NEWARK, N. J.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

VOL. XVII CHICAGO, JANUARY 15, 1913 No. 2

CHICAGO'S NEWEST CENTRAL STATION

Twenty Thousand Kilowatts in Each Unit and 12 Units to be Installed, Each Weighing 450,000 Lb., 109 Acres of Storage Ground and Park with an Individual Railroad to Supply 1656 Tons of Coal a Day

THE MARKED DEGREE in which the sale of electrical energy has increased within the past few years, especially in large cities, has brought about a new era in the design and construction of central stations, the tendency being to install fewer and much larger units than formerly, thereby greatly increasing the total efficiency of the station. Furthermore present practice is to centralize, as far as possible, the total power generated and deliver high-tension alternating current to substations where it is converted to low-tension direct current, by means of rotary converters and fed into the distribution system supplying the adjacent district.

These facts are well illustrated by the system of the Commonwealth Edison Co. in Chicago, which is one of the largest in the country utilizing coal for fuel. Of noteworthy importance is the new Northwest plant of this company, which when the project is completed, will include 2 similar groups of 6 20,000-kw. turbo-generators. This station is supplemental to 2 existing modern stations, one containing 10 12,000-kw. turbo-generators and the other 6 14,000-kw. turbo-generators.

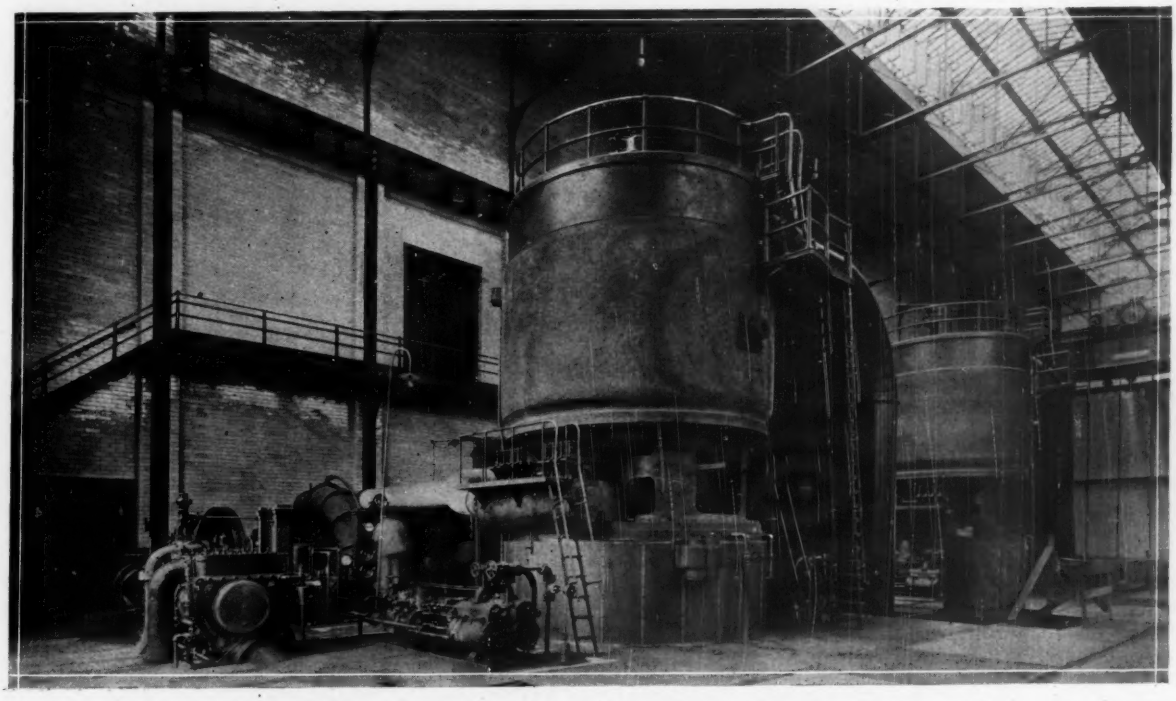


FIG. 1. ONE END OF TURBINE ROOM SHOWING 2 20,000-KW. CURTIS TURBINES

The new Northwest Station is located on the north branch of the Chicago River on a 109-acre tract of land, in the northwestern section of the city, about 7½ miles from the business center. As this is in a residential district, care has been taken to have an attract-

ive park surround the buildings. The plans call for 2 similar groups of buildings containing similar equipment arranged in the unit system, that is, with boilers and auxiliaries for each turbo-generator practically independent.

General Layout

ULTIMATELY there will be 2 groups of 3 buildings, each consisting of a boiler and turbine house, a transformer house and a switch house. The buildings are so placed that the best possible arrangement for the expeditious handling of fuel and circulating water supply is secured and at the same time the esthetic features have not been neglected. Structural steel and brick construction has been adopted with buildings of plain design, well separated to prevent communication of fire from one to another.

General dimensions of the buildings will ultimately be as follows: Boiler and turbine house, boiler room 275 by 121 ft., turbine room 290 by 70 ft., transformer house 290 by 28 ft., switch house 290 by 35 ft. Each half of the twin stations will comprise 6 nearly independent units placed side by side, consisting of 10 boilers, feed-water heater, pumps and auxiliary apparatus; a 20,000-kw. Curtis vertical turbine with condenser and accumulator for step bearings; electrical apparatus including transformers, control and measuring instruments. In the present boiler house one conveying outfit furnishes 2 rows of boilers with fuel but with the extension of the station, which now contains but 2 units, each row of boilers will have its independent coal supply. The complete coal handling equipment for 2 units has a capacity of 175 tons an hour.

Boiler Equipment

TEN Babcock and Wilcox water-tube boilers of the 3-drum type with 36-in. drums constitute a boiler unit. Each boiler is rated at 560 hp., with a steaming capacity 33,600 lb. an hour, giving a liberal reserve margin which takes care of the auxiliary apparatus and permits the regular cleaning of the boilers with maximum load on the turbines. Each boiler is equipped with a Babcock & Wilcox chain grate stoker and contains 14 rows of 4-in. tubes, 16 tubes to the row, the entire heating surface per boiler being 5600 sq. ft. The grate dimensions are: 10 ft. wide by 11½ ft. long, giving an effective area of 115 sq. ft. This type of grate is well adapted to burning the screenings used about Chicago for power plant purposes which contains about 10,000 B.t.u. per pound. Two hoppers are located below the grate, the one in front for the fine coal which drops unburned through the front end of the grate; the other for the ashes is located at the back end of the grate under the middle of the boiler. Standard Babcock & Wilcox settings are used for one unit, while the other unit has special settings similar to the Heine type.

Auxiliary apparatus for each boiler includes a single-loop superheater designed for 125 deg. super-

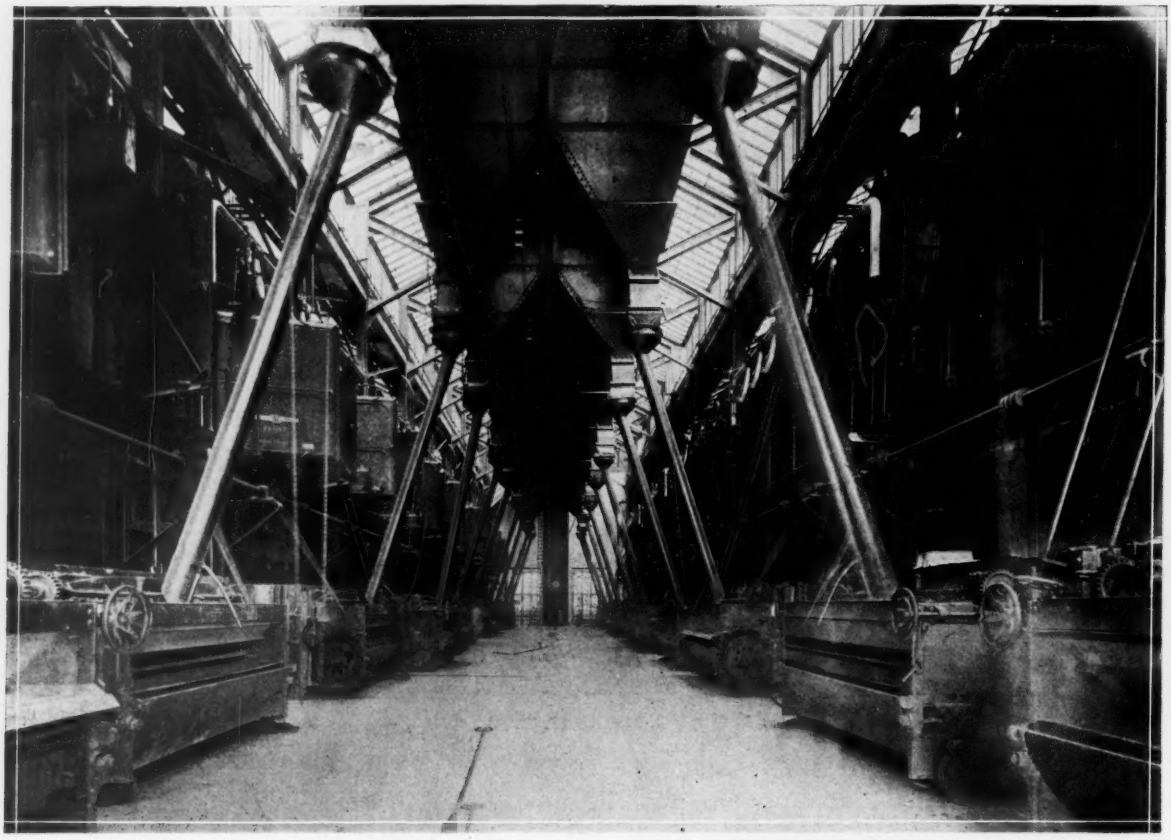


FIG. 2. BOILER ROOM SHOWING FRONTS OF 2 BOILER UNITS, CHAIN GRATE STOKERS AND COAL HOPPERS

heat at full steaming; Consolidated safety valve, B. & W. water column, Ashcroft steam gage; Edwards nonreturn and stop steam valves, and Edwards blow-off valve.

Steam from each battery of boilers is collected in a 16-in. header located in a header room below the rear ends of the boilers, and supported by roller bearings resting on the floor. The header is fastened at the turbine room end, where a Crane hydraulically operated valve is located; the boiler leads are of 6-in. pipe. To facilitate inspection and repairs, the tops of the boilers are conveniently arranged and provided with a continuous runway from end to end of the row.

To provide against the discharge of steam into the boiler room, endangering scalding the operators, the safety valves discharge into vertical open pipes ending above the roof. An 8-in. auxiliary header connects the boiler units, making it possible to use steam from one unit to supplement the supply from the other.

Stacks

WASTE gases for 10 boilers are taken care of by one stack, each stack being 17 ft. inside diameter and 18 ft. outside the steel shell, providing for a brick thickness of nearly 6 in. Three stacks are now completed, and 3 more will eventually be added; the height is 250 ft. above the boiler room floor and 210 ft. above the roof.

Each stack is built up of 22 rings of plates varying in thickness from ½ in. at the bottom to ¼ in. at the top, the total weight of the plates in one stack being 133 tons. Support for the stacks consists of braced steel structures resting upon individual concrete foundations, tied in with the main building frame to secure rigidity. Smoke flues rest on the roof trusses, the space above and behind the boilers being kept clear for the accommodation of piping.

Feed Water

FEED water is furnished to the boilers by 4 Worthington 5-in., 3-stage, centrifugal feed pumps, 2 for each boiler unit, driven by steam turbines at 2300 r.p.m., and designed to deliver 700 gal. a minute against 285 lb. pressure per square inch. The feed water is drawn from the feed-water heater and hot well at a temperature of 210 deg. F. A Worthington enclosed type heater is provided for each unit, and contains 4000 sq. ft. of heating surface; it can raise the temperature of 320,000 lb. of water an hour from 70 deg. F, at which it comes from the condenser, to the above value when supplied with steam at 2 lb. per square inch pressure, the steam for this purpose coming from several auxiliary engines and pumps. Make-up water is introduced by suction into the feed-water heater, the water level in the hot well being automatically controlled by a float valve.

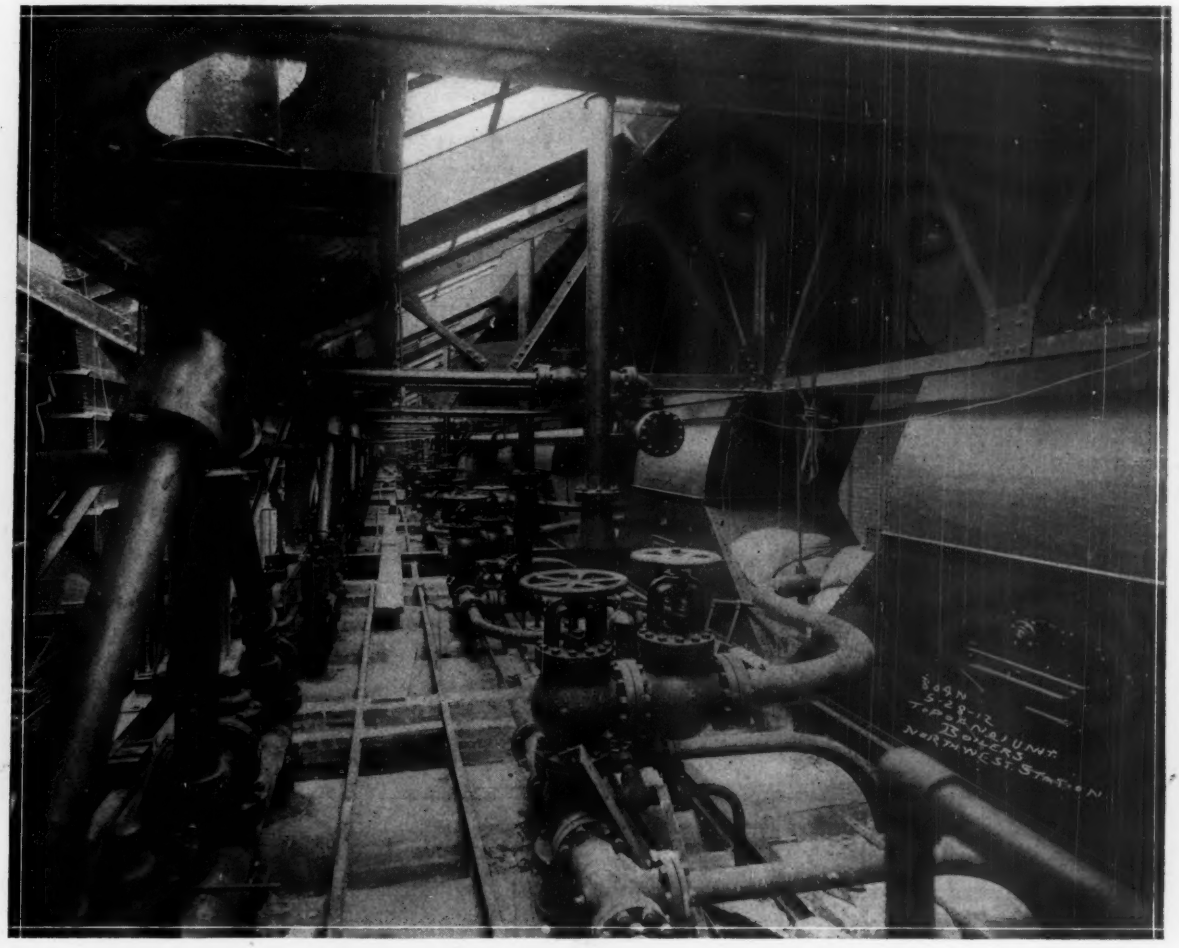


FIG. 3. TOP OF BOILERS IN NO. 1 UNIT SHOWING PIPING AND VALVES

Coal and Ash Handling

COAL will be received principally over the Chicago & Northwestern Railroad, which is less than a mile from the power plant and from that point be conveyed on a third rail electric railroad, of standard electrified steam road construction, built by the Edison Co. At the railroad end a large terminal yard will eventually be built so that the company can store several hundred coal cars. At present, electric locomotives of the Edison Co. take the cars from the railroad at the boundary of the property of the latter and either store them on the Edison Co.'s main track or haul them to the sidings at the power plant.

The coal storage yard which will eventually store 250,000 tons will lie between the twin stations. Over the piles, bridge cranes will be installed and the yard trackage so arranged that cars can be unloaded and reloaded, with minimum expense, by electrically operated clam shell buckets.

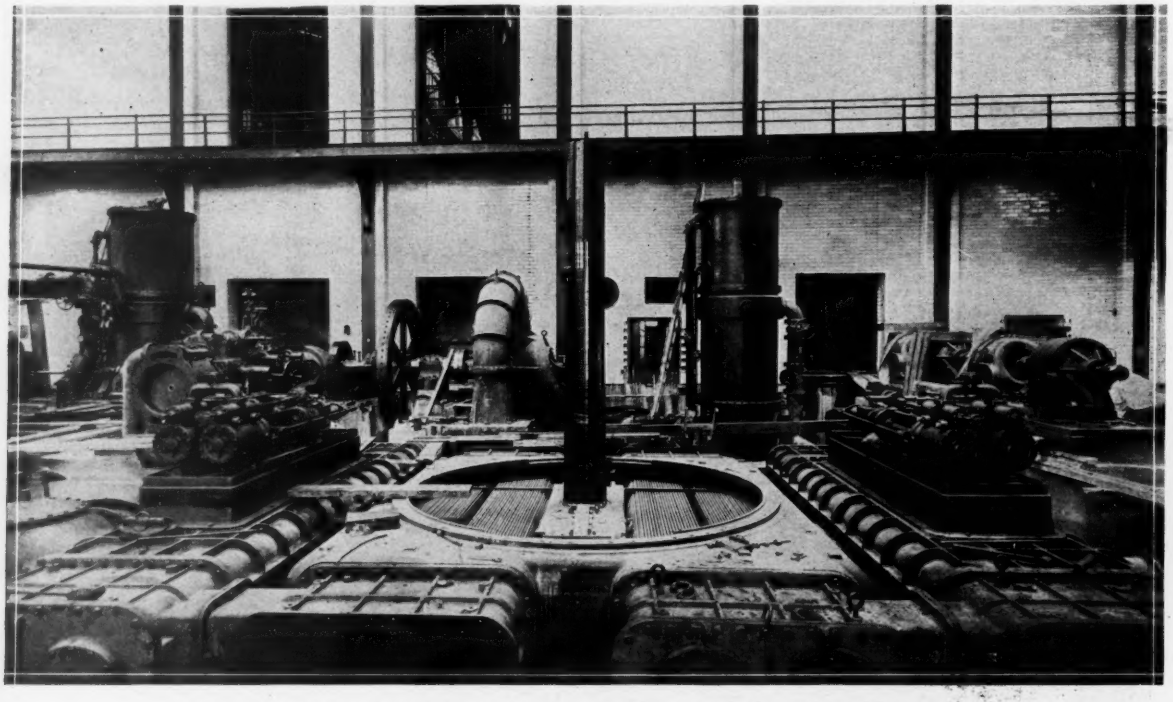


FIG. 4. CONDENSER FOR NO. 2 UNIT AS IT LOOKED BEFORE ERECTING THE TURBINE

Located between 2 rows of boilers under the firing floor is a long room 27 ft. high and 37 ft. wide in which are 9 concrete coal receiving hoppers with total capacity of nearly 1500 tons. Below these is a tunnel 16 ft. wide and 20 ft. high with a track for the portable coal crushers. On the floor of the tunnel is the bucket conveyor which takes the coal from the crushers, carrying it to the upper section in a monitor on the roof about 104 ft. above the floor of the tunnel.

One coal crusher is provided for each of the 2 boiler units; these are 4-roll crushers having 2 Cornish and 2 fluted rolls, the driving power for each crusher being a 3-phase, 60-cycle induction motor rated at 70-hp. Each crusher is also equipped with a 7½-hp. traversing motor of the same type. Specifications require that 95 per cent of the crushed product must pass a clear opening of ¾ in. The conveyor buckets are 34 by 36 in. and the speed is 45 ft. a minute, being driven by a 3-phase induction motor rated at 35-hp., located at the roof level. Through a reducing gear, the motor drives a large spur wheel and it is about fully loaded when the conveyor is operating at its rated capacity of 175 tons an hour. A ratchet arrangement has recently been added to the spur wheel to prevent accident in case of motor trouble.

Located over the boiler-room coal bunkers is the conveyor gallery for a pair of boiler units, which consist of a single row of bifurcated hoppers, one for each opposite pair of boilers. Each hopper holds 120 tons of coal, so that the total storage capacity in the building is 138 tons per boiler, sufficient for somewhat more than a day's requirements under the heaviest operating conditions.

Located on the ground floor is the coal-receiving room equipped for either dump cars or for ordinary coal cars. The former can dump their load directly into the receiving hoppers, but ordinary cars are unloaded by means of a clamshell bucket crane. The bucket has 2 cu. yd. capacity, and can handle 80 tons of slack or 60 tons of run-of-mine per hour. Its span is 34⅓ ft. from center to center of runway rails, and the maximum lift of bucket is 15 ft. Four 3-phase, 60-cycle, 220-volt motors are required for the crane as follows: 37 hp. on main hoist, 37 hp. on auxiliary hoist, 5 hp. on the trolley travel and 11 hp. on the crane travel. The fine coal hoppers under the boilers, already referred to, empty at the sides of the coal-receiving room into the receiving hoppers, and the fine coal thus finds its way through the crusher and the conveyor to the bunkers again.

On the ground level and on each side of the coal-receiving room is a space to accommodate the ash cars. A track is located directly under the spouts of the hoppers, connecting with the electric railway system already referred to. The ashes are at present used

for filling up land to be used later for track space. Each hopper has capacity for a day's accumulation of ashes.

Turbines

AS has been noted, the completed equipment will consist of 12 units, 2 of which are now in operation. They are Curtis 3-phase, alternating-current, 6-stage vertical machines operating at 750 r.p.m. and rated at 20,000 kw. at 4500 volts with armatures star connected. The rotor of the turbine contains 5 disks each carrying a double row of buckets. The rims of the disks are made up in detachable sections each of a convenient size for handling. In assembling, they are driven on the edge of the web of the disk and bolted through firmly; the buckets are held at the inside end in a dovetail groove in the rim sections. The first 3 stages have 28 double bucket sections of 24 buckets each; the last 3 have 28 double bucket sections of 20 buckets; the total number of buckets is therefore 7392. The diameter of the first stage wheel is approximately 11 ft. 10 in., and that of the sixth stage wheel slightly over 13 ft. The buckets vary in length in the 6 stages from 1¼ to 6⅝ in. on the top and from 2 to 18 in. on the bottom.

The weight of the steam end of the turbine is 401,000 lb., made up as follows: Main condenser shell, 141,000 lb.; wheel case and diaphragms, 166,000 lb.; wheels, 71,400 lb.; turbine shaft and coupling, 22,600 lb. Total weight of the generator end is 46,000 lb., made up as follows: Armature stool, 56,000 lb.; armature, 255,000 lb.; field, 105,000 lb.; top shield, 44,000 lb., making the total weight of the turbo-generator unit 861,000 lb., or 430.5 tons.

It will be seen that the rotating part of the turbine unit weighs approximately 100 tons, which is supported on a step bearing supplied with oil at 800 lb. pressure per square inch. The pressure is maintained at 1200 lb. by an R. D. Wood & Co. accumulator and 2 12 by 3 by 18-in. Worthington pumps of the duplex type, and is throttled down to 800 lb. at the bearing. One pump serves for the steady load and the other is in reserve.

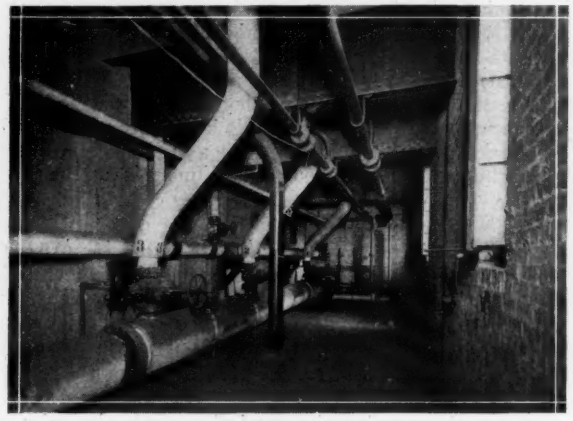


FIG. 5. EAST END OF HEADER ROOM SHOWING MAIN STEAM HEADER AND BOILER CONNECTIONS WITH VALVES

The bore of the accumulator is 8 in. and its plunger stroke 8 ft.; it is designed for 1500 lb. pressure and is tested to 2000 lb. The plunger is weighted down with iron weights, 4½ ft. in diameter, the object of the accumulator being to maintain practically a constant pressure on the step bearing, especially after any accidental stoppage of the pump and until the reserve pump is started automatically. Pressure for the upper bearings and hydraulically operated valve gear is supplied by 2 Worthington 6 by 4 by 6-in. pumps.

Condensers and Water Supply

EACH turbine is supplied by a Worthington condenser forming the turbine base at the floor level. It contains 3 sections, the main or center section with 3750 tubes, and 2 auxiliary sections with one-half this number of tubes each. Length of the brass tubes is 17 ft., and outside diameter 1 in., which is equivalent to 4.44 sq. ft. of surface. The total effective condensing surface is 32,000 sq. ft., or 1.2 sq. ft. per b.hp.

FIG. 6. SECTION OF THIRD RAIL ELECTRIC RAILROAD CONNECTING THE POWER STATION WITH THE CHICAGO & NORTHWESTERN RAILROAD

The condenser maintains a 2-in. vacuum when condensing 280,000 lb. of steam an hour and supplied with 40,000 gal. of circulating water a minute at 65 deg. F. The pump equipment of each condenser consists of a 36-in. Laidlaw, Dunn, Gordon volute centrifugal circulating pump driven by a 20 by 30-in. Corliss type engine at 120 r.p.m. This pump operates against a head of 20 ft., and delivers 40,000 gal. of water a minute. The cylinder of the dry vacuum pump is mounted tandem, with the Corliss engine cylinder which drives it, and displaces 2550 cu. ft. of air a minute. A Worthington turbine-driven, 2-stage, 5-in. centrifugal pump handling 660 gal. of water removes the condensation from the cendenser.

From the turbine room, concrete intake and discharge tunnels 10 ft. square run to the north branch of the Chicago River about 600 ft. distant. For a greater portion of the way one is directly over the other, the top being only a few feet below the ground level. The walls of the conduit are 2 ft. thick and the roof floor and dividing partition average about the same.

The discharge tunnel is below the injection tunnel, the latter drawing water from the river 450 ft. upstream from the outlet of the discharge tunnel. For preventing debris from entering the intake tunnel, its mouth is covered with a revolving screen which automatically cleans itself of accumulations. This screen, which is 5 ft. wide, is made up of sections covered with woven wire 16 in. long, forming a belt section which passes over an electrically driven drum at the top and an idler at the bottom and is inclined at an angle of about 30 deg. from the vertical.

Exciters

CURRENT for exciting the fields of the turbo-alternators is supplied by 2 exciter sets, one a 300-kw. Curtis steam turbine driving a 300-kw., 110-volt, d.c.

generator; the second set a General Electric 200-kw., 110-volt, d.c. generator driven by an induction motor. Either set can be operated independently or they may be operated in parallel.

Transformers

THE generator voltage of 4500 is stepped up to 9000 volts by means of General Electric auto-transformers, 3 being used for each unit and star-connected, thus having an independent auto-transformer for each phase with a capacity of 3333 k.v.a. each.

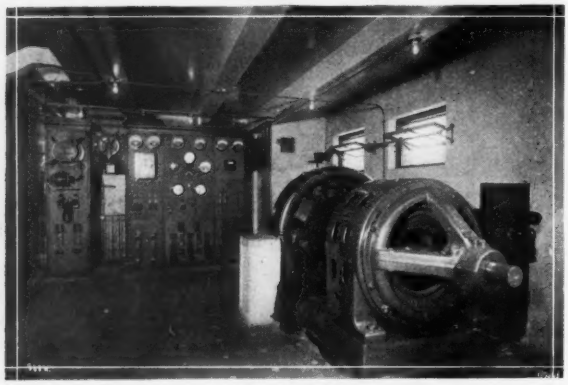


FIG. 7. EXCITER BAY SHOWING MOTOR-DRIVEN EXCITER AND SWITCHBOARD

These are located in the separate transformer building in separate rooms, and mounted on roller trucks so that by raising a corrugated sliding door any one may be pulled out on a platform where it is accessible for repairs. Both oil and water are used for cooling

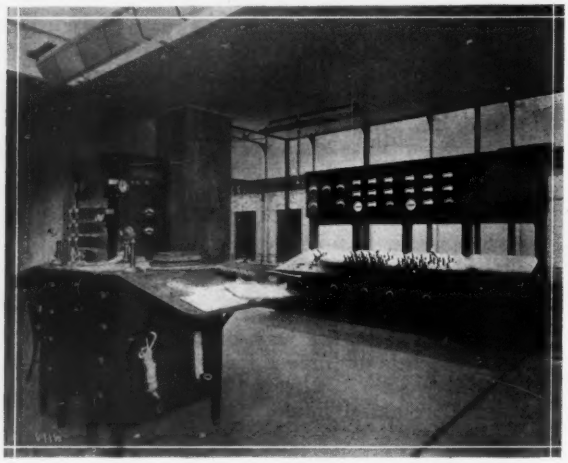


FIG. 8. OPERATING GALLERY, CHIEF OPERATOR'S DESK IN FOREGROUND AND GENERATOR CONTROL BENCH IN REAR

purposes and are circulated by pumps, the oil being used repeatedly while the water is discharged and wasted.

Operating Gallery

THIS is located on a mezzanine floor where a view can be obtained of the turbine room and is inclosed on that side by wire glass. The generators are controlled from a bench board and the feeders from feeder panels; the oil switches are located in a separate building, being equipped with remote control apparatus and actuated from remote control switches on the bench board. The usual controlling and indicating instruments that comprise the equipment, are of General Electric make.

Testing Set

ONE of the interesting features of this plant is the Westinghouse testing set consisting of a 500-k.v.a., 300-volt, single-phase generator, direct coupled to an induction driving motor with the exciter for the alternator mounted on the shaft extension. The generator voltage is stepped up to 33,000 by means of a stepup transformer and by means of suitable switches can be connected to any set of feeders or between any feeder and ground for the purpose of making breakdown insulation tests..

NEW FACTS ABOUT OUR EARTH

Old Theories Have Exploded, Axis Not Fixed, Equator Not a Circle, Sea Not Level, Earth's Center Not Molten

By Leonard Keene Hirshberg

AMONG the thousands of myths that relate to mother earth perhaps none is more familiar than that of the ancient one about Atlas or an elephant upon whose back the earth rested; both being in turn supported by a large tortoise. That this picturesque myth failed to state upon what the turtle stood, made it in no way invalid to the naive ancient.

Another notion, still extant in unfrequented places, is that the earth is built up of layers more or less, like an onion, or a nest of spheres. Certain premodern scientists also held that the center of the earth was a lake of liquid-like lava. This view was given its "quietus" when Lord Kelvin proved that the attraction of the sun and moon,—which cause our tides to rise and fall—would have caused the earth to burst, from its internal pressure, if the earth's crust was less than 2500 miles thick. The tidal force is so strong that even if the earth's layers were the hardest steel, it would yield as much as if it were rubber, from the force of the sun's and moon's attractions.

The most recent researches indicate that the earth's innermost part is made of the heaviest metals. These are no doubt harder and more solid than iridium steel. It is not necessary to mention many of the technical data to prove this. Suffice it here to say that earthquakes at the antipodes are recorded so quickly at Chicago and elsewhere, that the only explanation is that they pass quickly up through the rigid center of the earth.

Even the precise shape of the earth—in spite of textbooks' assertions—is not positively known. Nor does the earth spin steadily around a fixed axis, like a wheel around its spokes. The North Pole and the South Pole, the 2 axes of our earth, slowly change their positions; so also do the magnetic poles, which are not exactly coincident with the geographical poles. This apparently sedate old top of ours is not by any means as steady as you think. Here again, like certain attitudes of deacons in the church, appearances are deceiving. Instead of revolving in a round and narrow path, this old earth of our is actually executing a turkey trot, each moment shifting her axis. One explanation of this waltz-like motion, is the changing activities of the Polar ice-caps at the various seasons.

Children are taught at school that mother earth is an oblate sphere that is just like an orange, flat at both ends. The latest measurement given the earth through the poles is 27 miles less in diameter than at the equator. Peary's discovery of the North Pole and Amundsen's discovery of the South Pole serve to prove that the North Pole is much flatter than the South Pole.

Another new discovery is that the equator is not a circle, it varies considerable at certain parts of the girth.

Another fond fallacy of ours, exemplified in all sea-shore and mountain resort advertising, is the belief in a "sea level." As a basis of measurement, this is maintained everywhere and the impression is held that the sea is at the same level all over the land. Recent investigations have proved that the sea is far from level. There are mountain ranges of the ocean just as there are mountainous systems in land. The Pacific Ocean is actually 2000 ft. higher at one part of South America than the Atlantic Ocean, touching the same land exactly opposite. The Bay of Bengal stands 300 ft. higher than the adjacent Indian Ocean. One explanation of this is that the gigantic Himalayas exert an attraction that heaps up the waters of Bengal Bay, while the Andes do the same to the Pacific Ocean.

Another denuded idea, to wit that the atmosphere which surrounds the earth extends but 30 miles above the earth, has been displaced by scientific estimates which prove it to reach at least 150 miles. This is discovered by falling meteors and other strange visitors from other worlds than ours. When pieces of comets, their tails, or other particles of cosmic dirt come within the earth's attraction force, they fall to the ground. Since they then become incandescent, observations may then be made of the atmospheric distances through which they travel in a lighted state.

The deeper a trench is dug into the earth's crust, the higher ascends the mercury in a thermometer. For every 20 yards of descent, there will be a rise of one degree of temperature. At this ratio, 30 miles down would show an inferno hot enough to melt the heart of a Shylock and fuse the hardest metals or rocks known. Perhaps this explains the superstitions present in every ancient and modern religion, that the lower regions were made up of fire with a Pluto, a Devil, a Vulcan, as supreme dictators. It is now known that the heavy pressure of the surrounding layers of the earth, as well as its central force of gravity, preclude the possibility of such a thing as a fiery or liquid center.

The earth may now be weighed, and it is found to weigh 5½ times heavier than water. The surface of the earth is less than 3 times as heavy as water, so the weight of the entire globe is twice as heavy as the rocks we find. Thus it is established that the inside of the earth is heavier than fire, air, liquid or even its surface.

OIL AS EMERGENCY FUEL

Safeguarding Against Shutdown from Scarce Coal or High Prices by Providing for Use of Oil as an Alternative

By Reginald Trautschold

FUEL of some sort is necessary for the generation of steam, and fuel, for the majority of power plants, means coal. Precedence or tradition seems to be the main reason for this, as, unless other fuel is obtainable at a considerably lower relative price, practically every steam plant follows the practice in vogue since the days of James Watt. Numerous power plants, of course, operate on water power or depend upon various types of explosive engines, but the majority are steam plants.

To discard all steam generating equipment and install other types of power units is out of the question, but a change of fuel or rather ability to change readily from one kind of fuel to another when advisable is possible and deserving of serious consideration by every power house operator. The logical and practical substitute for coal is oil, and with these 2 practical fuels to be obtained in most localities, it is an economic blunder on the part of the management of every power house so situated not to be able to change from one to the other.

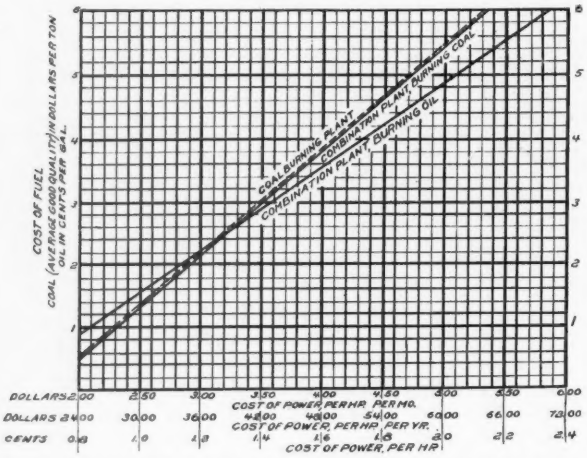
Installation of Oil Burners

ONE fairly large plant in the vicinity of New York was compelled to install oil burners in its coal grates during the coal strike of 1902, and since that date the operator of the plant, a manufacturer, has been practically independent of the fuel market—using coal when it was cheap and easily obtainable and oil when it could be had more advantageously. The initial expense of installing the oil burners and oil burning equipment was comparatively negligible and today the shutdown of a boiler at a time permits the changing from coal firing to oil burning, or vice versa, with no loss of power efficiency and at a small expense.

It may not have been foresight that brought about this particular installation but it is a fact that this fortunate manufacturer can now proceed with his business with relatively little anxiety concerning either his coal or oil supply. One fuel is practically sure to be obtainable at all times. But even hindsight should have placed the neighboring manufacturer in as advantageous a position. But thousands of manufacturers who suffered from lack of fuel during the great strike of 1902 learned nothing from the catastrophe and would suffer similarly from another such tie-up.

Some of the more farsighted operators, however, increased their coal storage capacity and many devoted considerable energy and money to increasing the efficiency of their plants by the installation of devices or equipment for minimizing the consumption of coal per horsepower. Such improvements are of importance, without question, but are they alone the best precautions that could be taken against possible shortage of fuel in the future? Authentic records of the economy of installations of oil burners under boilers would indicate that the addition of an auxiliary oil burning equipment to the average coal burning steam plant would make a better showing on the balance sheet. The object of this discussion, therefore, will be to present a conservative and reliable analysis of the relative economies of the ordinary coal burning plant and one that is equipped to burn either coal or oil.

Oil, as a fuel, has long passed the experimental stage, for every type of steam generator—on rail, afloat or stationary—has been economically, satisfactorily and efficiently operated on oil as well as on coal. In fact, under some conditions, oil has entirely superseded coal as fuel, and the absence of standby losses daily adds to the triumph of oil. The oil supply is limited, however, and cannot be counted upon at all times—the fluctuations in price of oil being greater and more sudden than those of the coal market. If this were not so, the use of oil as fuel would be more extensive than it is today, for in many localities its average relative price as a fuel compares favorably with that of coal. During the past 10 yr. the price of fuel has fluctuated through a range of 100 per cent,


COST OF FUEL
COAL (AVERAGE GOOD QUALITY) IN DOLLARS PER TON
OIL IN CENTS PER GAL.
COAL BURNING PLANT
COMBINATION PLANT, BURNING COAL
COMBINATION PLANT, BURNING OIL
DOLLARS
COST OF POWER, PER HR. PER MO.
DOLLARS
COST OF POWER, PER HP. PER YR.
CENTS
COST OF POWER, PER HP.

AVERAGE COST OF STEAM POWER BASED ON PLANT OF 500 HP.

a range too great to permit ordinarily its constant use as an economic fuel, but as an auxiliary fuel—one that is made use of only occasionally in emergencies—it may be found convenient and economical.

Oil Burning Equipment

INSTALLATION of an auxiliary oil burning system necessitates only a few minor alterations to the ordinary coal burning steam plant, the addition of the necessary piping and but little mechanical apparatus. The burners, themselves, should be located in the furnace door; either in openings cut in the regular door to admit them, which can be closed again when coal burning is resumed; or else, in extra furnace doors of firebrick for use only when burning oil. The balance of the equipment consists of the reservoir or oil tank which should preferably be located underground and away from the boiler room; apparatus for pumping the oil from the reservoir, for subjecting the oil to pressure before it is delivered to the burner and means for preheating the oil, all which operations may be performed by one piece of mechanism situated in a convenient location in the boiler room; a steam connection for vaporizing the oil; and the piping necessary for connecting up the system.

The steam connection consists simply of a pipe from the top of the boiler to the burner with a reducing valve along the line, though it is advisable to have means for superheating the steam before it is delivered to the burner. The regulation of oil and steam at the burner is usually accomplished by simple hand valves forming part of the mechanism of the burner. The admittance of air to the combustion chamber takes place through the firebrick covering necessary to protect the grates and exposed metal parts of the combustion chamber from direct contact with the flame from the burners and should be only rapid enough to assure proper combustion.

Once the oil burning system has been installed, the change from oil burning to coal burning consumes less than half an hour for a 250-hp. boiler; and the change from coal to oil burning is as easily and rapidly accomplished, once the fires have been pulled and the grates cooled sufficiently to allow their being handled. The change from coal to oil burning should, however, be made over night or at time of light load so as not to interfere with the operation of the plant.

TABLE I. AVERAGE FIXED CHARGES
Based on plant of 500 hp.

COST OF POWER UNITS, ETC.		
Engines, accessories, piping, etc.	$30	
Engine house, etc.	10	$45 per hp
Engine foundations, installation, etc.	5	
Depreciation	5%—total cost	
Repairs	2%—total cost	
Interest	6%—total cost	$7.20 per hp. per year, or 60c per hp. per month.
Insurance	1%—total cost	
Taxes	2%—¾ cost	—Item A
COST OF STEAM GENERATOR EQUIPMENT, ETC.		
Boilers, feed-pumps, etc.	$12	
Boiler house	5	$25 per hp.
Chimney and flues	8	
Depreciation	5%—total cost	
Repairs	2%—total cost	
Interest	6%—total cost	$3.87 per hp. per year, or 32.25c per hp. per month.
Insurance	1%—total cost	
Taxes	2%—¾ cost	—Item B
COST OF OIL BURNING SYSTEM, ETC.		
Burners, piping, etc. Pumping, heating and pressure regulating system, etc. Tankage, reservoir, etc. Installing system,		$3 per hp.
Depreciation	5%—total cost	
Repairs	2%—total cost	
Interest	6%—total cost	0.445 per hp. per year, or 3.708c per hp. per month.
Insurance	1%—total cost	
Taxes	2%—¾ cost	—Item C
COST OF OPERATION (exclusive of fuel)		
Boilers—using coal as fuel—$2.80 per hp. per year, or 23.333c per hp. per month.		—Item D
Boilers—using oil as fuel—$1.50 per hp. per year, or 12.50c per hp. per month.		—Item E
Engines—attendance,	$1.80	
Engines—oil, waste, supplies, etc.	.80	
		$2.60 per hp. per year, or 21.666c per hp. per month. —Item F

Total Fixed Charges—per horsepower

Item	Coal Burning Plant		Combination Coal and Oil Burning Plant	
	Per Year	Per Month	Per Year	Per Month
Item A	$7.20	$0.60000	$7.20	$0.60000
Item B	3.87	.32250	3.87	.32250
Item C			0.445	.03708
Item D	2.80	.23334	2.80	.23334
Item E			1.50	.12500
Item F	2.60	.21666	2.60	.21666
Handling Coal	2.70	.22500	2.70	.22500
Handling Ash	1.00	.08333	1.00	.08333
Total—per horsepower	$1.68083		Burning coal	$1.71791
			Burning oil	1.30124

Economic Considerations

THE first question that naturally presents itself to the power house operator is: For the generation of steam, when is oil as economic or more economic a fuel than coal? It is upon this point that the "evident" wisdom of an auxiliary oil burning system depends. Evident is emphasized, for other points pertaining to the elasticity and convenience of a plant equipped to operate on 2 fuels while less obvious are important. To analyze the "evident" points, the average total cost of developing one horsepower—including all expenses of operation, maintenance and the burden of interest on original outlay, taxes and insurance on

equipment—for a plant developing 500 hp. has been ascertained; 1st., for a coal burning plant; 2nd., for a plant burning coal, but equipped to burn either coal or oil; and 3rd, for such a combination plant burning oil. See Tables I, II and III.

In the case of using oil, the costs of operation and maintenance are considerably less than when burning coal, but in order to consider the relative efficiencies from the most conservative point of view, saving in labor only has been reckoned in arriving at the total cost of developing power by the use of oil burners under the boilers. Other savings, other than the absence of any charge for handling coal to and ash from the boilers, have been ignored. The data contained in Table III are also incorporated in the chart, from which the average cost of power per horsepower per hour, month or year with fuel at various prices can readily be ascertained for a plant of 500 hp. This chart is also approximately correct for a plant of any size, for in a larger plant the fixed charge per horsepower is less and the consumption of fuel per horsepower more economical, while in a smaller plant these 2 components of the total cost of power are increased. That is, the relation existing between the cost of fuel and the average cost of power may be considered as practically constant for all ordinary sizes of plants that are operated with average high efficiency.

Figure I shows that, in a plant equipped to burn either coal or oil, oil at 2.6c per gal—about 0.1c per gal. higher than the average price of fuel oil in New York—is as economical a fuel as coal at $2.60 per ton —about 25c per ton lower than the average price of steam coal in New York—and that a coal burning plant could deliver power at such a rate only when coal was less than $2.76 per ton, 18c a ton below the average price of coal in New York. In many localities good quality steam coal may be as high as $5.00 per ton and in such a case, oil at 4½c per gal., a figure that is higher than the highest price at which fuel oil has sold in New York during the past 10 yr., would be as economical and a much more convenient fuel.

It is true that the addition of oil burning equipment to a coal burning plant adds to the burden of interest, taxes and insurance but this increase is comparatively small—equivalent to adding 6.18c to the price of coal per ton—and may be taken care of by a judicious purchasing agent taking proper advantage of the usual spring cut in the price of coal when placing coal orders, and purchasing fuel oil when that commodity is procurable at an attractive figure, and by an economical operator who works with the purchasing agent in keeping the expense for fuel at a minimum—operating on oil when advisable and vice versa.

Figure I may possibly indicate that oil at the average market price in any given locality would be a more economical fuel than coal, but such deduction should be discounted, for the fuel oil supply in many localities is limited and the probable fluctuations in its price too great to assure economy in power production from its constant use. For instance, to quote from one of the large producers of fuel oil recently approached for prices: "At the present time, the price is —— cents per gallon, and we are not seeking additional business, the demand being greater than the supply." This, when the price quoted was 100 per cent higher than the lowest figure at which fuel oil sold in the particular city since 1902.

The same producer goes on to say: "This condition may not prevail next year" and names "a fair average price" that compares very favorably with the average price of coal in the same locality—a locality where the use of fuel oil in power plants or as an emergency fuel in such plants is rare. It would seem, therefore, that, as the purchase of a few thousand gallons of fuel oil—purchased at an advantageous time and maintained by renewals when that commodity is relatively cheap—is no great risk and the burden entailed in equipping a coal burning plant with oil burners is not great, an auxiliary oil burning system would be a profitable investment for many operators of coal burning power houses. Such an installation would enable a manufacturer to be practically independent of the fuel market—not that sometimes he might not have to pay a higher price for his power than at others but he would never be forced to pay the exhorbitant prices that the manufacturer, who depends upon one kind of fuel alone, may have to pay or shut down his plant.

TABLE II

AVERAGE COST OF FUEL—PER HORSEPOWER

Based on plant of 500 hp.

Cost of Coal		Cost of Oil	
Per Ton	Per hp. Per Month	Per Gallon	Per hp. Per Month
$1.00	$0.60	$0.01	$0.75
1.50	0.90	.015	1.125
2.00	1.20	.02	1.50
2.50	1.50	.025	1.875
3.00	1.80	.03	2.25
3.50	2.10	.035	2.625
4.00	2.40	.04	3.00
4.50	2.70	.045	3.375
5.00	3.00	.05	3.75
5.50	3.30	.055	4.125
6.00	3.60	.06	4.50

Average Efficiency:—

1 gal. of fuel oil will develop 3.37 hp.
1 ton of good quality coal will develop 500 hp. } used as fuel.

1 hp. per month requires 0.6 tons of good coal
1 hp. per month requires 75 gal. of fuel oil, } used as fuel.

1 hp. requires 4 lb. of good coal ..... 11½ hr. working day
1 hp. requires 0.2967 gal. of fuel oil ..... 10 hr. working day

TABLE III

AVERAGE COST OF STEAM POWER—PER HORSEPOWER PER MONTH.

Based on plant of 500 hp.

Coal at per ton	Burning			Oil per gallon
	Coal (Coal plant)	Coal (Comb. plant)	Oil (Comb. plant)	
$1.00	$2.28083	$2.31791	$2.05124	$0.01
1.50	2.58083	2.61791	2.42624	.015
2.00	2.88083	2.91791	2.80124	.02
2.50	3.18083	3.21791	3.17624	.025
3.00	3.48083	3.51791	3.55124	.03
3.50	3.78083	3.81791	3.92624	.035
4.00	4.08083	4.11791	4.30124	.04
4.50	4.38083	4.41791	4.67624	.045
5.00	4.68083	4.71791	5.05124	.05
5.50	4.98083	5.01791	5.42624	.055
6.00	5.28083	5.31791	5.80124	.06

Convenience in Oil as Fuel

THE foregoing cover the "evident" points in regard to the wisdom of an auxiliary oil burning system for coal burning steam plants, but there are certain other advantages resulting from oil fuel for steam boilers that should not be overlooked and which also affect the wisdom of the double system. Certain conditions and requirements must also be met by the apparatus or equipment installed to assure proper economy in the generation of steam by oil burners. These points, though perhaps subordinate to the evident points, are of importance and will be touched upon briefly.

Advantages and convenience of oil fuel for steam boilers led J. A. F. Aspinal, a prominent engineer and a fellow countryman of the father of steam power, James Watt, to write—"The use of liquid fuel may be called an ideal method of raising steam, . . ." Advantages that may be called basic or fundamental are: 1st., the fact that oil is very much more easily handled than coal; 2nd., that oil can be stored at less expense than is possible in the case of coal and when stored does not deteriorate (as does coal to some extent); and 3rd., convenience. More particular advantages are; decrease of loss of heat generated in the furnace, due to the possibility of keeping the boiler and its tubes free from non-conducting deposits precipitated from the gases generated in coal burning and to the diminished amount of air that must pass through the combustion chamber in order properly to burn the fuel; increased efficiency, owing to the more equal and constant distribution of heat in the combustion chamber — the furnace door not having to be opened; ease with which the intensity of the fire can be regulated; lessening of labor; the absence of expense in handling fuel; and the saving in the disposal of ash. These advantages, as would be expected, all tend to increase the steaming capacity of boilers from 20 to 40 per cent more than when coal is used as the fuel.

Conditions and requirements that must be met by the oil burning equipment are numerous but they have all been surmounted at the present time, enabling the manufacturer or operator of a coal burning steam plant to purchase an oil burning system for emergency use that will meet all the claims of the conservative makers of such equipment.

Before touching upon the conditions required of the apparatus, it is well to anticipate the criticism that oil is an unsafe fuel, liable to accidental ignition, etc. Oil with a fire test of about 180 deg. is really as safe as coal, for even this latter commodity may sometimes ignite from spontaneous combustion. Ordinarily specifications for fuel oil call for a fire test of from 250 to 300 deg., and such oil may be safely stirred with a red-hot poker without danger of ignition and a shovel full of hot coal will be extinguished if thrown into oil of such character.

For the requirements of an efficient installation, oil must be supplied to the burner under sufficient and constant pressure, conditions that are usually obtained through the use of small pumps and pressure chambers. The oil must be thoroughly atomized (a very fine spray or vapor) as it leaves the tip of the burner, which is usually accomplished by the aid of a steam jet from the boiler. Such a jet uses but about 1½ or 2½ per cent of the output of the boiler, an amount that is negligible—or may be considered as costing nothing—on account of the increased steaming capacity of a boiler fired with oil. Care should be taken in admitting only the requisite amount of air to the combustion chamber, for, as in all furnaces, an excess of air has a cooling effect on the chamber and reduces its efficiency. The storage tank, or oil reservoir, and the majority of the piping should be placed underground, the storage tank being properly vented, thus guarding against an increase in the insurance rate on the equipment and plant.

Flame issuing from the burners should always be directed against an arch or wall of firebrick, not against any metal part of the boiler. This latter condition is possibly the most important of the requirements for a satisfactory installation, but of almost equal importance is that of the supply of air. This must not be in excess of 15 per cent of that actually required for complete combustion but again it must be sufficient for such combustion. The combustion chamber should show a clear white incandescence with little apparent flame and no smoke, another advantage of oil burning, or unburnt gases would issue from the smokestack.

Inasmuch, therefore, as the initial outlay necessary for equipping coal burning furnaces with auxiliary oil burning apparatus is inconsiderable; as the average cost of one fuel amounts to about the same as the average price of the other in many, if not the majority of localities; as there is no increase of labor required for oil burning over that required when using coal as fuel—on the contrary, a considerable saving may be made in the pay-roll; and inasmuch also as almost invariably oil may be obtained at sometime during the year as readily and advantageously as coal; there would then seem to be no reason why any factory need experience a shutdown from that state of affairs so much dreaded at the present time, namely, a shortage of coal.

ISOLATED PLANT COSTS

Discussion of Costs and Conditions Given in Former Article which Tend to Disprove the Superiority of the Isolated Plant

By Lewis C. Reynolds

THE article entitled "Isolated Plant Wins" in the Oct. 15 issue, is but another example of how unreasonable many engineers are when dealing with the subject of central station service. Of course, opposition is to be expected from engineers in charge of small isolated plants, the dismantling of which would mean loss of position to the men operating, but it would perhaps be better form to meet the matter squarely, rather than exaggerate the economy of the isolated plant and deceive themselves by belittling the advantages and economy of central station service.

In the present case, we have a plant with rated capacity of 85 kw. and an output of 3133 kw. for the month of February and a corresponding small load in other months. As February had 25 working days, this would be 125 kw. a day or 12.5 kw. an hour for a 10-hr. day, not a very startling output for a plant of this capacity.

The coal consumption reaches 10 lb. per kw. or about 3 times the quantity which is required by its central station competitor but not far from the average of small isolated plants.

Only 2 of the expense items are given in the article, but analyzing these for February, we find the fuel per kw. cost $.0205 and oil and waste $.0016. Though it is not so stated, we must assume that someone is in attendance 10 hours a day and 6 days a week and in addition, some overtime for cleaning and repairing, and as it appears, the engineer is to be classified as a professional man and would, at least, be entitled to $75.00 a month and do all the work of the plant from handling the coal in, to watching the kilowatts out. This would add to the operating costs $.0239 per kw.-hr. He should not he required to act as fireman, oiler and all-round plant man and perhaps he does not; however, the article does not consider the labor item in operating costs and we have assumed it at a figure low enough to give the isolated plant the advantage of any error on our part.

It is interesting to note that contrary to the usual practice of isolated plant experts, the item of depreciation has not been overlooked. This is usually considered a bookkeeping frill by those in the plant, but to the owner who draws his check to cover replacement, there is nothing mysterious about it. An estimated first cost of $10,000 on the 2 boilers, engines, generators with pumps, heater, switchboard, stack, piping, foundation, etc.,would be a very low valuation, but we wish to be well within the actual cost. Allowing 5 per cent interest on the investment and 5 per cent depreciation and obsolescence with 2 per cent for taxes and insurance would make a fixed charge of $1200.00 a year or $100.00 a month, which on February output, would be $.0319, which is the largest single item of cost. We have, up to this point, $.0779 per kw. in items which are beyond dispute and still have numerous items which are difficult to determine exactly, but, if taken at 1 cent per kw., would nearly equal the $.09 rate of the central station. One cent per kw. for repairs and supplies is a high unit figure for the ordinary plant, but in this case, it is due to the output being but a small proportion of the rated capacity and would amount to $31.33 for the month in question. It is questionable if this would cover renewal of grate bars, repairs to fire brick furnace linings and arches, occasional tube renewals and the smaller items of flue cleaner, steam hose, gaskets, gage glasses, scoops, engine and pump packings, etc., which, in the aggregate, amount to a considerable sum. In this item must be included hauling away ashes, city water, and central station service after regular hours as stated.

The owner is continually taking the risk of a serious defect showing up on a boiler requiring complete retubing or expensive patchwork, the engines are liable to injury which would require costly replacements and the generators to burned out windings or damaged commutator.

The article contains several inconsistent statements which may be due to the writer's not stating plainly what he meant or to our misunderstanding of their meaning. It is stated that the engines do not carry more than ⅔ of their capacity while our figures show that it averages only 1/7 of the capacity and that the plant does not use its capacity over 1½ hr. a day. It is also stated that the plant can take an additional load without increasing operating expenses. This, of course, is incorrect. The cost per kilowatt will, however, decrease as the fixed charges will remain constant for quite an increase in load and the increased output will, of course, act to reduce the unit cost of production. In fact, right here is the vulnerable point of isolated plants. The equipment for such a small installation has an exceedingly high first cost per kw. of capacity and in order to have reliable service, the units must be in duplicate, making the total capacity about twice the maximum demand. Taking into consideration the load factor of the plant, the actual output will be but a small proportion of the rated capacity and dividing the fixed charges by the total output, will often give a unit cost per kw., on this single item, in excess of the central station rates.

The central station rate in this case is excessive and this would be a profitable day load at less than half the former 9-cent rate, as it would be largely off peak business. Taking into consideration this high central station rate and the omission in the cost calculation of the isolated plant, the latter has appeared to win, but to any fair-minded engineer who will put all self interest aside and consider the case on the merits, it should be plain that if conditions are stated correctly, the size and characteristics of the load are such that it can be served more cheaply by the central station plant and that the large investment made to carry it was unwarranted.

AN INTERESTING REMEMBRANCE

ONE of the pleasant features at the annual meeting of the American Society of Mechanical Engineers was the dinner given to Prof. John E. Sweet in celebration of his 80th birthday. This was held in the Engineering Societies' Building on Dec. 4, and was notable as well for bearing a worth-while remembrance of a life of memorable accomplishment, and the first dinner to be held in the Engineering Building.

There were some 250 guests present, many of them famous in the field of steam engineering, and many telegrams from all over the world were received congratulating Prof. Sweet on his long and useful service.

One of the most noteworthy of these was from John Fritz, who has done so much to improve steel rail manufacture in this country, and whose 90th birthday came on August 21 last. Prof. Sweet's birthday was on October 21 last, and Toastmaster Swazey expressed the wish that in view of the great benefit which Mr. Fritz and Prof. Sweet had been to engineering, all engineers might have been named "John" and born on the 21st of the month.

The events of Prof. Sweet's life were reviewed by the different speakers, and his achievements in connection with the high-speed engine, the Sweet valve and the steam engine governor were outlined. Also his work in organization of the Society was dwelt upon and the great part which his interest and efforts had played in bringing the society through its early years to success.

Other speakers who paid tribute to the work of the principal guest of the evening were Dr. Humphreys of Stevens Institute of Technology, Capt. R. W. Hunt of Chicago, Prof. A. W. Smith of Sibley College, Cornell University, Dr. John A. Brashear of Pittsburgh University, who spoke of one of Prof. Sweet's early engines which is still running in the university laboratory after 20 years of service.

In response, Prof. Sweet told of some of the recollections of his 80 years of life, and of the inventions and mechanical developments during that time, and spoke appreciatively of the recognition of his work and the evidence of their esteem.

A REPORT from an American consular officer in a Latin-American country states that a company in his district asks to be put in communication with American manufacturers of electrical machines for the copying of plans and blue prints, machines for drying the copies, technical papers used in this branch of business, and the latest appliances and apparatus for the production of plans and blue prints, as well as novelties for architects, constructors, and engineers. Correspondence and advertising literature should be in Spanish or French. Prices should be quoted c. i. f. city of destination. It is urged that American manufacturers pay particular attention to the details indicated above.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

IN THE EARLY DAYS

Stories from the Life of Horatio A. Foster, Which Show How Far We Have Traveled in a Few Years on the Electric Way

AT the November meeting of the New York Electrical Society, the speaker of the evening was Horatio A. Foster, the helpful desk companion authority on electrical matters, whose address was entitled "Reminiscences of an Electrical Engineer."

Mr. Foster told first how as a young man becoming interested in electricity, he was employed in the shops of the Daft Electric Motor Co., of New York City during the year of 1885, and, after some 3 months' work, was sent to Baltimore to take charge of the first "electrification" of a steam railroad.

Mr. Daft's idea was to have a third rail system with the potential so slow that a person could grasp it and the return rail, yet suffer no inconvenience or injury.

When the system was completed and connected to the generator, it was found that they could get no voltage several miles away, which, on investigation, was found to be due to the poor bonding. Mr. Foster conceived the idea of bonding the rail joints by riveting copper wire to the rail and the system was then found to be very satisfactory.

There were 2 motors of 7½ hp. capacity, which barely propelled the cars up a certain 7.5 per cent grade on the road, so that Mr. Foster used to sit pouring water on the contact pulley running on the third rail to diminish the contact resistance while negotiating that grade.

In the "power house" were neither instruments nor switchboard, and no one knew what the working potential was, or whether the generator fulfilled the requirements of the design.

As the road was troubled a good deal by animals getting on the road and across the third rail with fatal results, that rail was sunk and partially covered by a wooden board, an early example of a protected third rail.

Experting for the Thomson-Houston Co.

IN August, 1886, Mr. Foster joined the Thomson-Houston Co., and was placed in the "Expert" Department, which consisted of young men who were learning the business. Why these were called "experts" he did not know. The maximum time anybody spent in that department was 3 months, at the end of which period Mr. Foster was sent to a large cotton mill at North Adams, Mass., where a plant for electric lighting had just been installed. Wiring had been done poorly; Mr. Foster knew nothing of wiring calculations, but neither did anybody else at that time, and he rewired the place according to his best guess.

The switchboard was a wooden affair with no switches or instruments, metal clips joining the feeders with the mains coming from the 400-light dynamo, and regulation being made by trial until it maybe looked right.

During an 8 months' stay in Maine as sales agent, it was interesting to note, that not a single sale was made! About that time the company was entering railroad work and was making some installations in Philadelphia. Mr. Foster, therefore, applied to be transferred into that department in view of his "previous experience in railroad work," with the result that he was transferred into the motor department and after a little while sent to Philadelphia. Here he became a "doctor of electrical machinery," locating and remedying trouble on electrical apparatus. An incident related shows the attitude of some of the electrical experts at that time. At the Stetson Hat Co., a large Thomson arc generator was being used and gave a great amount of trouble owing to the blower not working properly. (Those who have had experience with this type of generator know that air insulation is used between commutator segments, and that the blower was used to free these air gaps from foreign particles which would tend to bridge between them.) Mr. Foster was sent to remedy the trouble and took the blower apart, cleaned the parts and replaced them, meanwhile explaining their function to the engineer in charge. The engineer was highly pleased and said that Mr. Foster was the first man who had allowed him around while the machine was being repaired. Others who had been sent, ordered all out of the room, locked the doors, and forbade entrance. The doubt arises, did they do anything to the blower or even understand its working?

About this time some of the tank steamers of the Standard Oil Co. were being fitted with electric lights. One came into port with the brushes and commutator in terrible shape, and investigation showed that the brushes were made of bunches of hard wire, the grinding action of which on the commutator can be readily imagined. Mr. Foster made up leaf brushes of copper and supplied the engineer with a medium size roll of thin copper strip to replace the worn out brushes when needed. Imagine his surprise when a request for another roll of strip was made when the vessel next arrived in port with the statement that the spare roll had been used on the voyage!

Pioneer Work in New York Central Stations

IN 1888 Mr. Foster was appointed superintendent of the E. 24th St. station of the Thomson-Houston Co. in New York City. This was the first attempt of the company to obtain a foothold in the electric lighting of New York City.

The plant had old type Babcock & Wilcox boiler with the caps at the end of the tubes screwed in, giving a large amount of trouble from leakage. Wires were strung from the telegraph poles, as those in authority stated that underground conduits were impossible.

With a change of city government changes in this direction were made. The various engineers were called before the mayor and told that unless a start was made within 3 days to lay the cables underground all wires of the company north of University Place and 14th St. would be cut down. The engineers merely laughed to themselves, but at the end of the 3 days the city began chopping down the wires! A number of accidents had occurred by people coming in contact with these wires which were hung quite low.

First Niagara Falls Plant

AFTER some journalistic experience during the World's Fair of 1893, Mr. Foster became associated with Professor George Forbes, who had been appointed electrical engineer of the Niagara Falls Power Co. A commission of engineers, American and foreign, met in London to decide the means of transmitting the power from Niagara, and it was decided to transmit electrically, and, though much against the advice of the late Lord Kelvin, by means of 2-phase alternating current. It was decided to build one canal and use turbines of 5000 hp. at 250 r.p.m.

Designs for the generators were invited, specifications calling for a rotating element of weight not greater than 80,000 lb., and possessing a flywheel effect of 1100 million foot-pounds.

In the designs received, no attention was paid to these requirements, with the result that Professor Forbes set about a design, the result being the now familiar "mushroom" or "umbrella" type of rotating field.

Bids were then invited from the manufacturers for a machine of this type, and The Westinghouse Co. agreed to undertake the contract if it could redesign the machine to accord with its shop practice. Professor Forbes agreed to this provided the "umbrella" type of field was retained so as to produce the necessary flywheel effect. The design came back and Mr. Foster was assigned to calculate the weight of the rotary field. This he found to be some 79,560 lb., when happening to turn the drawing over he found the figures for the weight on that side. His feelings can be imagined.

In the transmission line between Niagara Falls and Buffalo, Mr. Foster conceived the idea of stringing barbed iron wire above the transmission wires with the idea of protecting them from lightning; just how or why, he did not know, but he thought it ought to be a good thing. The number of lightning storms that summer was large and they were severe, and it is interesting to note that not a single case of trouble with the transmission line was recorded. In the winter, however, the wire began to rust and break, falling across the transmission wires which were burned and broke. This gave so much trouble that it was decided to take the barbed wire down entirely.

Consulting Engineer

IN 1900 Mr. Foster removed to Philadelphia, where his offices were in a Trust Co. building. One day he was approached by the president of the trust company who asked him how he would like to be president of a brewery? He replied that he wouldn't.

A few weeks later he was asked how he would like to be the receiver of a brewery. Reply as before. Another few weeks elapsed. "How would he like to be a co-receiver of a brewery?" Reply also as before. But after being told the state of affairs, he was finally persuaded to help in the reorganization, with so much success that the brewers used to say "If you want a brewery run properly, get an electrical engineer!" (Did anybody make a remark about manufacturing "juice"?)

Associated with L. B. Stillwell in electrical work in Baltimore in 1907, it came about that 21 years after installing the first electric railway he was engaged on its redesigning and rebuilding.

MOTOR TRUCKS

Latest Developments in Design; Rapid Increase in Number Used

FEW persons realize how rapidly gasoline and electric delivery wagons and trucks are coming into use throughout the country. In Massachusetts the registrations increased from 2189 on Sept. 1, 1911, to 3560 on the same date in 1912—an increase of 1371 or 62½ per cent. In Washington, D. C., there are now 500 motor trucks and wagons where a year ago there were 218, and in Los Angeles, Cal., where there were 70 a year ago, there were nearly 1300 on November 1, 1912, an increase of more than 1700 per cent. There has been a 120 per cent increase in Chicago in the last year, with 2,094 trucks registered in September as compared with 800 registered in May, 1911.

There are estimated to be 50,000 in use in America at the present time, and basing prediction upon the increases shown, the number will be nearly doubled during the year 1913. There are indications on every hand that business men are at last convinced of the reliability, superior efficiency and economy of the motor wagon in its many forms and are now converting their horses and wagons into equipment as fast as conditions permit.

Express companies, contract delivery and transportation companies, storage warehouses, department and dry goods stores, city fire, police and street departments, brewers and coal dealers, are especially active just now in placing large orders for motor trucks.

All of the new models of the best makes of trucks, incorporate such recent improvements as self starters, demountable and automatic dump bodies, left side steer and center control, differential locks, worm drive, shaft drive in electric vehicles, sealed speed governors, spring-supported power plants, demountable tires, and so on. These will be brought together for easy inspection and comparison at the Chicago Automobile Show, the second week of which, from February 10 to 15, is reserved for the exhibition of commercial cars and accessories exclusively. This offers the only chance of the year to see 75 or more different makes in one city at the same time, and consequently the only opportunity to get posted on all of the improvements of the year and the wide range that is offered for selection in sizes, construction and prices.

THE MAN WITH a hammer is a knocker with a purpose, and his noise means something even though it is simply a by-product.

PRACTICAL ELECTRICAL ENGINEERING

Calculating the Size of Conductors for Direct-Current Lighting and Power Circuits

IN every electric circuit there is resistance to the passage of current which causes a drop in the electromotive force, the loss of energy manifesting itself as heat. In calculating the size of a conductor for a given current or number of watts it is customary to allow for a given drop in voltage depending upon the character of service, length of the circuit and the electromotive force.

From the study of Ohm's law we learned the relations existing between current, electromotive force and resistance. From these laws formulas have been derived for determining the proper size of conductors for varying conditions. Before taking up these formulas, however, let us review a few of the characteristics of copper wire and the wire table.

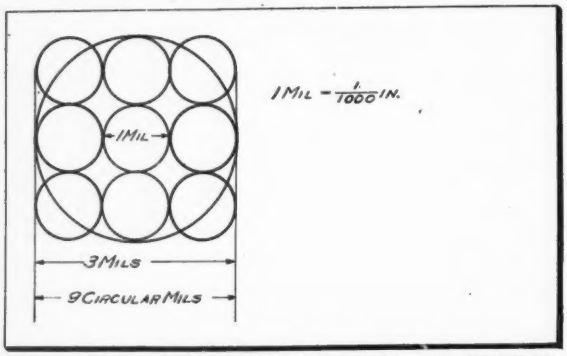


FIG. 1. GRAPHIC ILLUSTRATION OF MILS AND CIRCULAR MILS SHOWING AREA IN CIRCULAR MILS = d^2 AND AREA IN SQUARE MILS = $d^2 \times 0.7854$

It has been experimentally determined that the resistance of a foot of commercial copper 1 circular mil (abbreviated c. m.) in area is 10.8 ohms at 75 deg. F.; this is generally accepted as 11 ohms, as small refinements are unnecessary because the purity of the metal is not known and furthermore the difference between available sizes of commercial insulated copper wire, that is even numbers, is about 60 per cent.

By reference to the table of dimensions, weights and resistances of copper wire in the Practical Reference Tables, it will be noted that areas are given in circular mils and square mils. Area in circular mils = d^2, as shown graphically in Fig. 1, and area in square mils = $d^2 \times 0.7854$; a mil = 0.001 in.

The wire table B. & S. gage, has simple relations, such that by remembering a few constants the whole table can be constructed with approximate accuracy. A wire which is 3 sizes larger than another wire has approximately half the resistance, twice the weight and twice the area. A wire which is 10 sizes larger than another wire has 1/10 the resistance, 10 times the weight and 10 times the area.

In Fig. 2 are given 8 formulas covering practically all electric circuit problems met with in everyday practice, for direct current work and in the following paragraphs a problem to which each formula is applicable is given with the solutions shown in Fig. 3, in which the Roman numerals correspond to those in Fig. 2.

The resistance of a copper conductor varies directly with its length and inversely with its area, therefore it is evident that the product of the length of the conductor in feet, times the constant 11, divided by the area of the conductor in circular mils will give the resistance in ohms as shown in formula (I) Fig. 2. What is the resistance of a 250,000-c.m. cable 1 mile or 5280 ft. in length?

Constant 11 refers to the total length of wire, that is, the combined length of 2 conductors in a 2-wire circuit. For convenience in figuring problems involving the size of conductors, the constant is taken as 2 by 11 or 22 which applies to the length of the circuit and not the length of the conductor.

Formula (II) Fig. 2 states that the drop in volts (e) in a circuit is equal to the continued product of the constant 22, the current in amperes I and the length of the circuit in feet L, divided by the area of the conductor in c.m. If the current is 10 amperes, the line 100 ft. long and the area of the No. 2 conductor 66,373 c.m., what is the drop in volts?

By reference to formula (III), Fig. 2, we find that the required area in c.m. of a conductor to carry a given current is equal to the continued product of the constant 22, the current in amperes, I, and the length of the circuit, L, in feet divided by the desired or allowable drop in volts, e. What size of conductor is required to transmit 100 amperes 750 ft. with a drop of 3 volts?

Formula (IV), Fig. 2, states that the current in amperes is equal to the product of the voltage drop and area of the conductors in c.m., divided by 22 times the length of the line in feet. If a line 600 ft. long with a conductor area of 26,250 c.m. has a drop in voltage of 5, what current in amperes will flow?

Key to Symbols

(I) $R = \frac{11 l}{A}$, in ohms

(II) $e = \frac{22 I L}{A}$, in volts

(III) $A = \frac{22 I L}{e}$, in c.m.

(IV) $I = \frac{e A}{22 L}$, in amperes

(V) $L = \frac{e A}{22 I}$, in ft.

(VI) $A = \frac{22 N i L}{e}$, in c.m.

(VII) $A = \frac{2200 P L}{p E^2}$, in c.m.

(VIII) $A = \frac{P 746 L \times 22 \times 1.25}{E e X}$, in c.m.

R = Resistance in ohms
l = Total length in feet of conductor
A = Cross sectional area in c.m. of conductor
11 = Constant equal to a c.m. ft. of commercial copper at 75 deg. F
22 = Constant x 2
e = e.m.f. drop in volts
I = Current in amperes
L = Length of circuit in ft.
N = Number of lamps
p = drop of voltage in percent
P = Power in watts
E = Volts
X = Efficiency
c.m. = circular mils
i = Current per lamp

FIG. 2. FORMULAS FOR CALCULATING ELECTRIC CIRCUITS

In Fig. 2, formula (V) states that the length of a circuit in feet is equal to the product of the drop in volts, e, and area of the conductor, A, in circular mils, divided by the product of the constant 22 and the current in amperes I. What is the length of a

circuit whose allowable drop in volts is 1, the area of the No. 10 conductor in circular mils is 10,381, and the current flowing is 5 amperes?

When it is desired to figure the size of a conductor for a given number of incandescent lamps, where the current taken by each lamp is known, formula (VI) of Fig. 2 should be used. It states that the required area of the conductors in circular mils is equal to the continued product of the constant 22, the number of lamps N, the current required for each lamp, i, and the length of the circuit in feet L, divided by the drop in volts. What size wire is required to furnish current to 100 16-c.p. carbon incandescent lamps at the end of a line 600 ft. in length each lamp to take ½ ampere, with a drop of 5 volts?

Frequently, it is desirable to figure the size of wire necessary to carry a given load in watts; this can be done by using formula (VII), of Fig. 2, in which the constant is 2200 and instead of using the drop in volts as a factor the percentage drop in volts expressed as a whole number is used and is designated by p; the power in watts is represented by P and the electromotive force E is squared.

The formula reads, required area of conductor in circular mils is equal to the continued product of the constant 2200, power in watts and length of line in feet divided by the product of the percentage drop in volts and electromotive force squared. What size conductor will be required to furnish current at 110 volts, 1000 ft. distant, for a load of 5000 watts, or 5 kw. with a 2 per cent drop?

(I) $R = \frac{11 \times 5280}{250{,}000} = \frac{58{,}080}{250{,}000} = 0.23$ ohms

(II) $e = \frac{22 \times 10 \times 100}{66{,}373} = \frac{22{,}000}{66{,}373} = 0.33$ volts

(III) $A = \frac{22 \times 100 \times 750}{3} = \frac{1{,}650{,}000}{3} = 550{,}000$ c.m.

(IV) $I = \frac{5 \times 26{,}250}{22 \times 600} = \frac{131{,}250}{13{,}200} = 9.9$ amperes

(V) $L = \frac{1 \times 10{,}381}{22 \times 5} = \frac{10{,}381}{110} = 94.3$ ft.

(VI) $A = \frac{22 \times 100 \times 0.5 \times 600}{5} = \frac{660{,}000}{5} = 132{,}000$ c.m. or No. 00 Wire

(VII) $A = \frac{2200 \times 5000 \times 1000}{2 \times 12{,}100} = \frac{11{,}000{,}000{,}000}{24{,}200} = 454{,}545$ c.m.

(VIII) $A = \frac{100 \times 746 \times 200 \times 22 \times 1.25}{220 \times 5 \times 0.92} = \frac{410{,}300{,}000}{1012} = 405{,}434$ c.m.

FIG. 3. SOLUTION OF PROBLEMS BY FORMULAS GIVEN IN FIG. 2

For calculating the size of conductors to supply current to direct-current motors formula (VIII), of Fig. 2, will be found useful. The underwriters' code requires that the conductors supplying a motor shall have a carrying capacity 25 per cent in excess of those used for an equivalent lighting load, to take care of overload conditions frequently imposed upon the motor. This excess is represented by the constant 1.25 in the formula which reads: the required area of the conductors is equal to the continued product of the horsepower rating of the motor P, 746, number of watts per horsepower, the length of the circuit L in feet and constants 22 and 1.25, divided by the continued product of the voltage E, the drop in voltage, e, and the efficiency of the motor, X, expressed decimally.

For direct-current motors operating at 110 or 220 volts, the efficiencies may be taken as follows: One-half hp., 73 per cent; 1 hp., 77 per cent; 2hp., 82 per cent; 3 hp., 83 per cent; 5 hp., 84 per cent; 7.5 hp., 86 per cent; 10 hp., 88 per cent; 15 hp., 86 per cent; 20 hp., 87 per cent; 25 hp., 89 per cent; 50 hp., 91 per cent; 75 hp., 92 per cent; 100 hp., 92 per cent; 150 hp., 93 per cent; 200 hp., 93 per cent.

What size conductors will be required for a 100-hp., 220-volt direct-current motor, efficiency 0.92, located 200 ft. from the source of current supply, with an allowable drop of 5 volts?

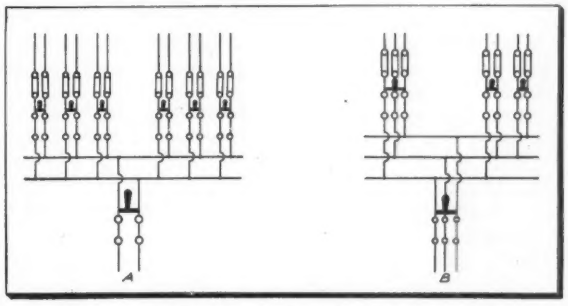


FIG. 4. TWO-WIRE AND 3-WIRE DISTRIBUTION

The size of conductor B. & S. gage nearest to the required area in circular mils can be found in the table of dimensions, weights, and resistance of pure copper wire in the Practical Reference Tables. The minimum size of insulated wire allowed by the underwriters on account of mechanical strength, is No. 14, B. & S. gage. When figuring the size of conductors for any load, reference should be made to a wire table to check the carrying capacity of the wire called for by the solution of the problem.

In Fig. 4 is shown the common 2-wire distribution A, and 3-wire distribution, B. When calculating the size of conductors, the size of the feeder from the meter to the distribution panel should be figured for the total load distributed from the panel, then each branch figured separately for its load. For 3-wire systems figure as for a 2-wire system and divide the result by 4.

The following problems are given for practice which will familiarize the reader with not only the formulas but the use of the wire table.

What is the resistance of a wire whose area is 105,538 c.m. and length 620 ft.?

If the current is 190 amperes, the line 137 ft. long and the area of the conductor 211,600 c.m., what is the drop in volts?

What size conductor is required to transmit 62 amperes 825 ft. with a drop of 2 volts?

What size conductors will be required for a 200-hp. 220-volt direct-current motor, efficiency 0.93 per cent, located 210 ft. from the source of current supply, with an allowable drop of 3 volts?

THE KENTUCKY UTILITIES CO., which recently bought the United Water, Light & Traction Co., will soon begin improvements on the plant at Somerset, Ky. Manager J. L. Waddle says that the company has ordered the construction of a new power plant, the cost of which will be about $75,000. A new filter and pumping station is under construction and will be ready for use by spring.

STORAGE BATTERY PRACTICE

Method of Softening the Negative Plates; Evaporation Gage for Pilot Cells

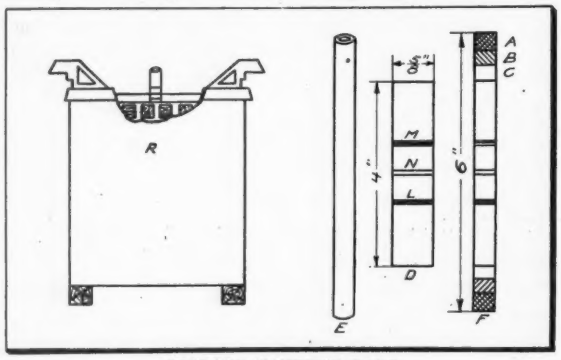
By M. C. Saeger

MANY storage batteries suffer from lack of sufficient charge, also from standing for long periods partly discharged, which results in sulphating and hardening of the negative plates, causing a drop in potential and loss of capacity. In the paste type of negative plate this hardening can be detected by prodding a section of the element with a knife blade which should sink in to half the depth of the grid when the plate is in active condition. If it does not or only makes a scratch mark on the element, the plate should be treated to a softening process to restore its normal capacity.

After the square surface of the negative plate is measured, a sheet of lead is cut to the same size, with an extending strip which will be used as a terminal. These sheet lead plates are known as dummy positive plates, there being one more negative plate than sheet lead plates in the assembled unit.

When assembling for the softening charge, the best type of separator to use is perforated hard rubber sheets which allow complete circulation of the acid between positive and negative plates.

The action of the electrolyte is more pronounced in the softening process and the best results are obtained when it is diluted to a specific gravity of 1.025. The charging current should not exceed one-half the normal rate and the charge should be continued for at least 72 hr. Testing the condition of the negative element with a knife during the charge will show when the plates have reached the required softness, thereby obtaining their normal capacity.



STORAGE BATTERY GAGE

The battery should then be reassembled with the original positive plates and separators using electrolyte with the manufacturers prescribed density. A charge of 4 hr. at the normal rate should then be given for the benefit of the positive plates, after which the battery will have attained the normal capacity and potential. The sheet lead plates may be retained and used over again; the low density electrolyte should be thrown away as it will contain a large quantity of deposited sulphate.

Evaporation Gage for Pilot Cells

A CONVENIENT appliance for the pilot cell, to determine the amount of evaporation of the electrolyte can be constructed with very little effort. In cells using an automatic water feed this gauge will show if the automatic feeder is working too fast or too slow, also in hand feeding of water to the pilot cell the gage will allow the operator to keep the electrolyte at a standard level.

The hydrometer reading is effected by different levels of the acid; for example, say, the hydrometer reads 1.200 at a normal height, ½ in. evaporation will change the reading 1 to 2 points. The sudden flooding of water to bring up the acid level to normal, will lower the specific gravity 1 to 3 points, this wide variation of the acid density due to evaporation and compensation with water is more evident in hand fed cells.

By use of the gage, compensation can be made at short intervals, keeping the acid level constant. To construct the gage, a glass tube, shown at E, 5/16 in. inside, 7/16 in. outside diameter, and 6 in. long should be used. A plain sheet of paper 5/8 by 4 in. with a red line ruled at N, and 2 black lines ruled at M and L, will answer for the indicator, standing for maximum, normal and low marks.

The paper is slipped into the tube, and a small piece of cotton C, is then forced in each end as shown at F. Corks B are next forced in the tube, spaces A being filled with hot sealing wax. The tube should be placed upright between two of the plates in the cell as shown at R.

WATER JACKET TROUBLES

"MOST city water contains large quantities of lime and magnesia in solution and these coming in contact with the heated walls of the air compressor precipitate in the form of scale. This scale cuts down the radiating capacity, the air compressor overheats and the efficiency is very greatly reduced. Not only this; but, due to the pressure, the water in the jackets has been known to leak through the packing and get into the cylinders, causing wet air with its attending troubles."

The above is from an exchange which need not be identified. It is a fact that water jackets will not and do not keep clean of themselves, but require cleaning out with a frequency determined by the condition of the water used. As there is practically no evaporation there is little or no deposition of scale as in a steam boiler, but mud or sediment sometimes accumulates rapidly, so that the clearest water obtainable should be used.

The last sentence of the above paragraph is absurd. There is generally no pressure upon the water circulating in the water jacket, never it may be said, as much as within the air cylinder, and in most constructions—packing or no packing—there is no possible communication between the water jacket and the cylinder interior. When there is "wet air with its attending troubles" the water is carried in by the air itself, and there is never any absolutely dry free air taken in.—Compressed Air Magazine.

Atlantic Ice and Coal corporation is erecting a large ice factory and cold storage compartment in Americus, Ga. Eighty-five thousand dollars is the estimated cost of this modern plant, which will have a manufacturing capacity of 75 tons of ice daily. Provision will be made for cold storage for meats, fruits and vegetables and the icing of fruit trains. The plant will be among the most complete in Georgia.

At Bridgeport, Conn., the S. W. Hubbell Building Co., has taken the contract to build a power house at the plant of the Acme Shear Co.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

LARGE GAS POWER STATION IN JAPAN

Containing 4 2500-hp. Double-Acting Gas Engines. Details of the Engines

By W. A. Tookey

FOUR Nurnberg 1500-kw. gas power alternators now in process of erection at the Railway Power Station of the Imperial Japanese Government at Kamata, near Yokohama, represent the latest practice in gas engine construction and as such will have points of interest for readers of Practical Engineer.

The order for the plant was secured by The Power Gas Corporation, Ltd., of Stockton-on-Tees, England, the proprietors of the Mond system of power gas production, and this firm sublet the contract for the engines to The Lilleshall Co., Ltd., of Oakengates, England, the British licensees of the Maschinenfabrik Augsburg Nurnberg (the well known German firm which has so successfully developed the four-cycle, double-acting gas engine for large powers). In order to comply with the time limit for delivery and erection the Lilleshall Co. elected to build 2 of the 4 engines at their own works and to obtain the other 2 from the M. A. N. Co. of Nurnberg. The writer inspected the engines when erected in the makers' shops before shipment, both in England and in Germany, on behalf of the Power Gas Corporation, Ltd.

Mere figures convey but an inadequate idea of the actual size of the completed machines and although some drawings illustrate this article which, when compared with the scale, hint at the magnitude of the engines, yet the halftone block showing the flywheel which is used as the rotor of the alternator, will give a better idea of dimensions, seeing that a workman is included in the picture from which comparisons "leap to the eye."

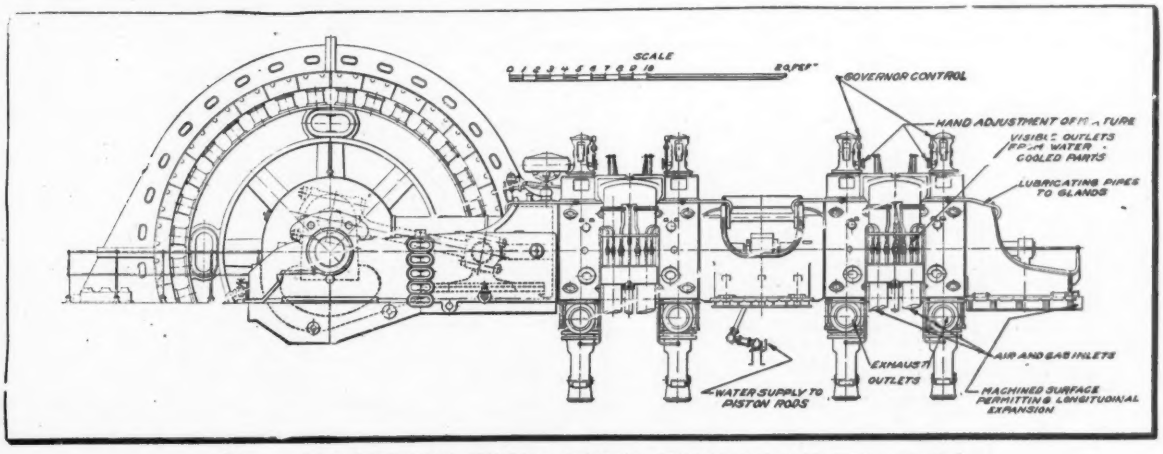


FIG. 1. SIDE ELEVATION SHOWING GENERAL ARRANGEMENT OF THE ENGINES

General Construction

AS will be seen, each engine consists of 2 tandem, double-acting cylinders of 47½-in. bore. The stroke of the pistons is 51 in. Each individual cylinder weighs 25 tons. The engine was designed to give 2500 to 2600 brake hp. at 100 r.p.m., but as at Kamata the engines will run at 94 revolutions and generate 1500 kw. the output under working conditions will be about 2130 hp. The total weight of engine and flywheel is 400 tons, of which 100 tons is in the flywheel.

Following the standard practice of the constructors, the utmost care has been taken to ensure that all 4 engines should be the exact replica one of the other, so that any detail of one shall exactly fit any of the others and the provision of spare parts will thus be available for either set. The whole of the work has been done to limit gages, and jigs have been used wherever possible, so as to obtain the desired interchangeability of repair parts.

The Frame

A FEW notes upon the details of construction are given so that the characteristic features of the latest Nurnberg design can be appreciated. The forward portion of the engine bed is made in 2 pieces to facilitate transport. These 2 pieces are coupled together by links shrunk into place, as shown in the drawings. The cylinders are provided with turned seats at each end so that they can be erected in true alinement without difficulty. The cylinder covers are secured by a separate ring of bolts and, being much

smaller in diameter than the end bed-plates and the central distance piece, allow ample space for access to the interior of the cylinders when moved out of position along the piston rods. It will be noticed that particular attention has been given to ensure a symmetrical form of cylinder so as to avoid distortion when hot, and that a very ample space has been left for water in circulation round the jacket. Numerous doors have been fitted to the latter for cleaning purposes while the water is made to enter at the hottest portion and to leave at the coolest.

Valves

INLET valves are nearly flush with the internal walls of the cylinder. They are operated by eccentrics from the side shaft, and are mounted on the top of the cylinder. The eccentric rod is coupled to the uppermost of a pair of rolling levers, between which is placed a sliding block moved backwards or forwards by the action of the governor. By this method the actual lift of the inlet valve is controlled and quantity governing obtained. Between the rolling levers and the valve head 2 annular spaces are arranged. In the upper one gas is admitted while the lower one is for air. From the separate drawing of the inlet valve it will be seen that a telescopic inner shell is provided at the apex of the gas passage immediately within the air space near to the valve seat, the gas passing through a series of ports around a conical outlet. It will also be observed that a rotatable slide is provided around the air port at this place by means of which the proper proportions of air to gas can be effected, as may be necessary. The adjustment of mixture is made by slightly rotating the valve spindle, to which the slide is attached, in the manner depicted in the drawing. The lever and connections giving the required movement will be observed just under the contact point of the valve spindle beneath the lower rolling lever.

The exhaust valve is operated by the same eccentric as the inlet valve and the mechanism is separately shown. Generally it is worked on the same system, but in this case there is no need for varying the lift. It will be seen that no provision has been made for water cooling this valve. The makers' experience shows that this complication is unnecessary, provided that the exhaust valve seat, particularly, and also the casing, are thoroughly water cooled. The disposition of the metal in the casing has been carefully worked out so that no undue stresses should be set up. Attention of the reader may also be directed to the sliding hood under the head of the exhaust valve so as to

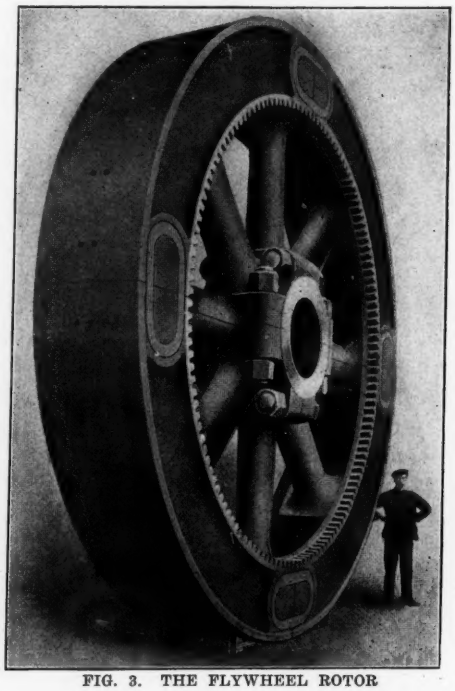


FIG. 3. THE FLYWHEEL ROTOR

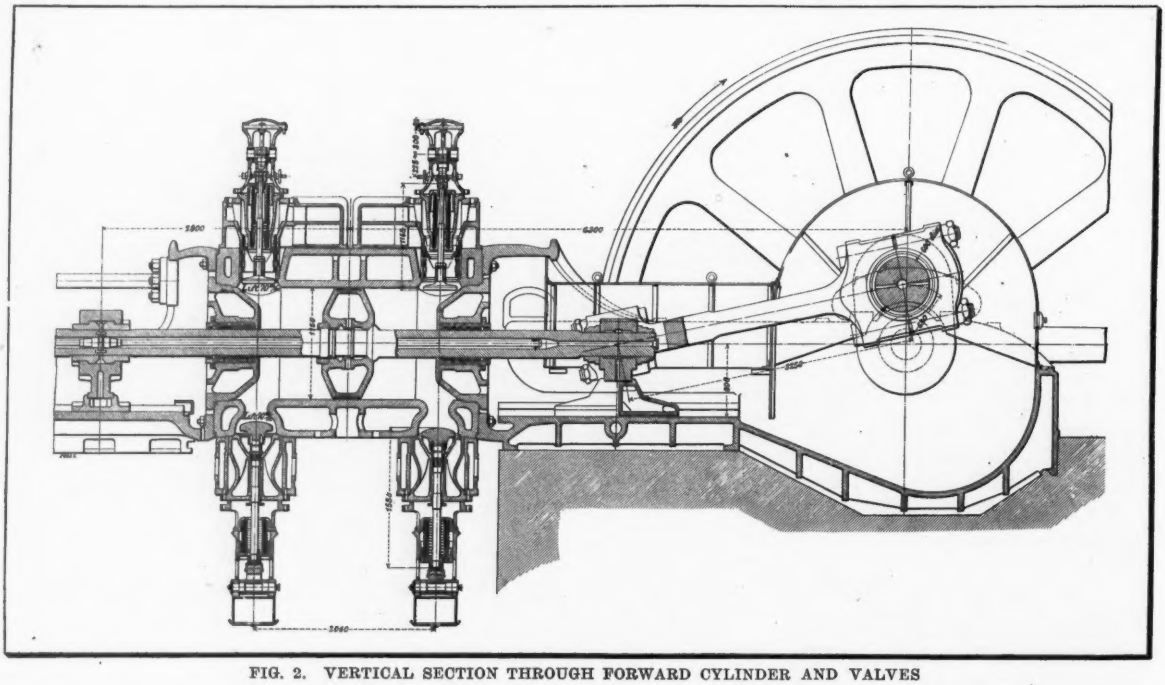


FIG. 2. VERTICAL SECTION THROUGH FORWARD CYLINDER AND VALVES

shield the spindle and guide from the flow of heated gases.

Pistons and Cylinders

THE piston is bolted to a conical seat formed on the rod, by a fine threaded nut, the latter bedding to the piston against a rubber joint which makes a thoroughly water-tight connection. The whole weight of the pistons is carried by the crossheads to reduce wear at the cylinder and glands. The rods are therefore made with a slight chamber so that when loaded with the

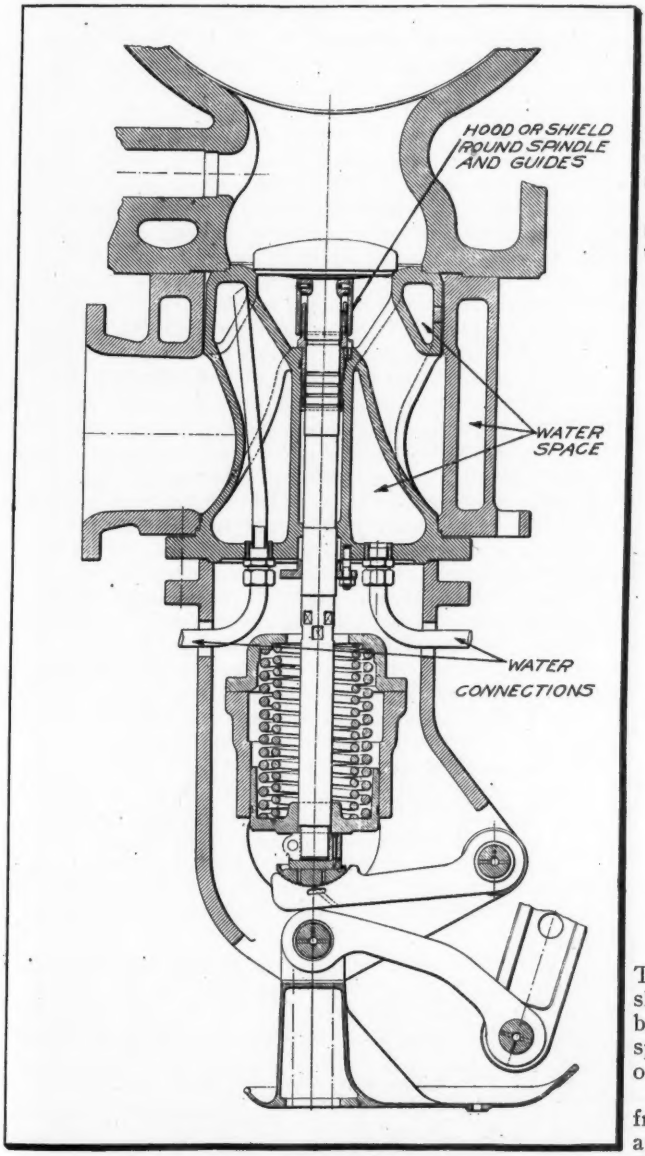


FIG. 5. SECTION OF EXHAUST VALVES

piston they become straight. The supply of water for the interior of the piston is obtained from the rods to which the water is admitted through swinging link connections at the central crosshead. Each piston rod terminates with a screwed cap at the central crosshead within which the swelled ends of the caps fit. The crosshead is made in 2 parts, the upper forming a keep which is firmly bolted to the lower. The rods are made of crucible steel and are each of exactly similar dimensions so that one spare as well fits the front cylinder as it will the back.

At each end of the cylinder 3 low-tension ignition plugs are fitted, operated by electromagnets, the current being taken from a battery of accumulators. The engine is started by compressed air at 300 lb. per sq. in. admitted through independent ports with valves operated by the side shafts.

Side shafts are made in 2 portions. The main crankshaft gear wheel drives the front portion of the side shaft at 1½ times the speed of the engine and from this the governor is driven. Close to the governor drive a reduction gear is placed so as to rotate the remainder of the side shaft at half the speed of the crankshaft. The diameter of the crankpin is 600 mm. (23 in.) and the diameter of the shaft at the flywheel seating is 820 mm. (32¼ in.). The shaft is of Siemens Martin steel and runs in 4 part bearings of steel lined with white metal.

Nickel steel forms the front crosshead, having the small ends forged solid with it. The slipper secured to the crosshead is of cast iron shod with white metal.

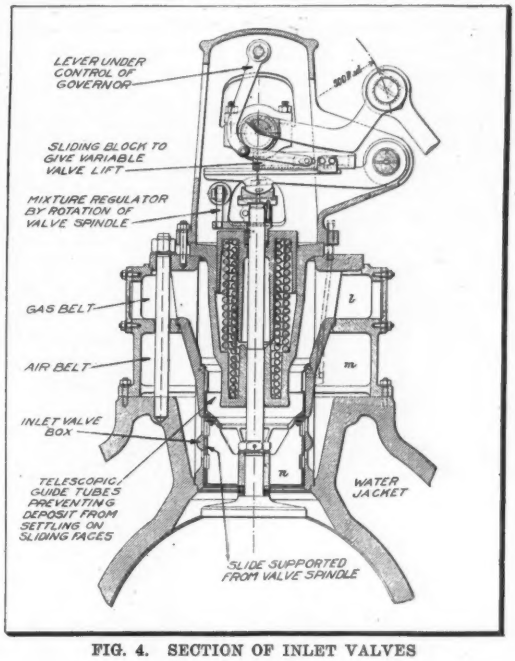

LEVER UNDER CONTROL OF GOVERNOR
SLIDING BLOCK TO GIVE VARIABLE VALVE LIFT
MIXTURE REGULATOR BY ROTATION OF VALVE SPINDLE
GAS BELT
AIR BELT
INLET VALVE BOX
TELESCOPIC GUIDE TUBES PREVENTING DEPOSIT FROM SETTLING ON SLIDING FACES
WATER JACKET
SLIDE SUPPORTED FROM VALVE SPINDLE

FIG. 4. SECTION OF INLET VALVES

The glands are packed with cast-iron rings turned slightly smaller than the rod and split. Each is backed by a floating metallic packing kept tight by springs. The glands are lubricated by forced-feed oilers worked from the side shaft.

The cylinders themselves are supported quite clear from the foundations by the distance piece and front and rear guide beds. The forward bed frame only is firmly bolted down, the distance piece between the cylinders and the rear guide bed resting upon machined surfaces to which they are secured in such a manner as to allow full freedom for longitudinal expansion.

Gas and air pipes to each end of the cylinders are 14 in. in diameter. The exhaust is into an 18-in. main and an expansion joint is provided between each pair of cylinders. This main discharges into a tubular boiler and thus raises a large part of the steam required for the Mond Ammonia Recovery Producers.

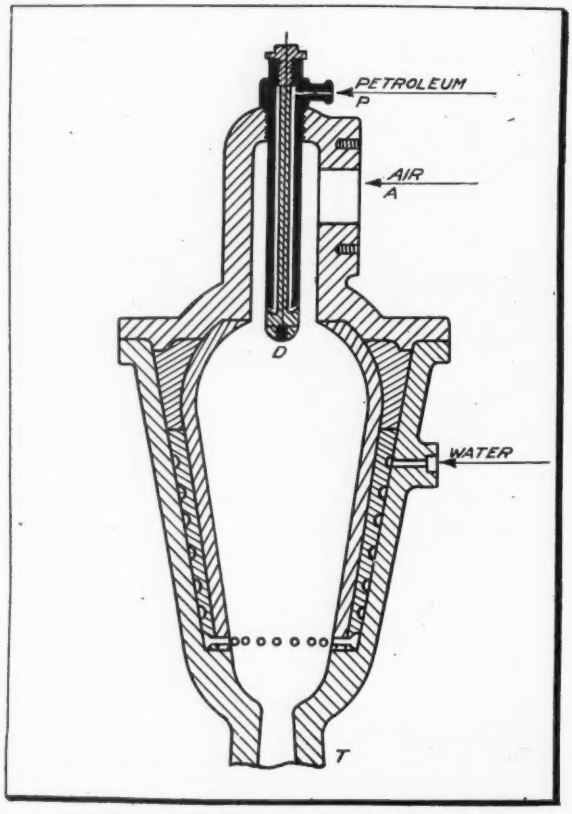
For transportation of one engine from the makers' works at Lilleshall to the port at Birkenhead, a special freight train was chartered to do the journey of 65 to 70 miles. Owing to the heavy weight in the 7 cars upon which the parts were loaded, the train was not allowed to travel faster than 5 miles an hour, the journey taking about 14 hours, starting at 5 a.m. on Sunday.

THE GAS TURBINE

Translated from Le Gaz, August, 1912

WE have recently considered explosive gas turbines or gas turbines of discontinuous pressure, and have noted the inferiority of the principle of these appliances from the point of view of thermal efficiency. In the second category come combustion gas turbines, or gas turbines of constant pressure. In this case we have, on the contrary, a constant motor couple; under these circumstances the steam turbine may become a gas turbine without essential modifications.

The gas and air are previously compressed, then conducted into a combustion chamber in which they are burned, and the products of combustion are conducted by suitable passages to the vanes of the motor wheel. The combustion of the gaseous mixture produces a greater energy in expanding than was expended in the preliminary compression.



COMBUSTION CHAMBER OF ARMENGAUD-LEMALE PETROLEUM TURBINE

A combustion turbine includes always: 1. A combustion chamber. 2. The necessary passages between combustion chamber and motor wheel. 3. The motor wheel. 4. The compressors for gas and air, as accessory appliances.

For the thermodynamic study of this motor it is necessary to take into consideration: 1. The extreme limits of temperature and the extreme limits of pressure, of the cycle; and, 2. The relation of the work of compression of gas and air to the energy produced.

Temperatures as high as 1800 or 2000 deg. C. can be attaned in the combustion chamber with gas; with petroleum a temperature as high as 2600 deg. C. may be reached. At the outlet of the vanes, 400 deg. C. is permissible; certain steam turbines (working with superheated steam) work with such a temperature at the motor wheel; if tungsten or vanadium steel is used, it is said that a temperature as high as 600 deg. C. can be supported without injury.

It is in traversing the passages between the combustion chamber and the motor wheel that the gases are cooled, in transforming pressure into speed; their velocity on leaving the combustion chamber may reach 1000 m. (about 3250 ft.) a second, according to Mons. Lemale.

This lowering of the temperature some eight or nine hundred degrees, in order that the heat in the wheel chamber may not rise much above 400 deg. C. is accomplished in this form of turbine by cooling the combustion chamber with a current of water. The cooling water may be allowed to escape without further utilization, or it may be returned in order to make use of the steam generated. This steam may be used in a special independent turbine, or it may be used in the same turbine. When used in the same turbine it may be injected into the combustion chamber; or it may, by means of special passages, be directed upon the vanes of the motor wheel; or lastly, it may be carried into the expansion tuyere.

The first method of cooling is of course disadvantageous from the point of view of efficiency, since the heat taken from the gas does not aid in the production of motor force, at least in the same motor.

It is possible to imagine the lowering of the temperature taking place after expansion instead of before; this method, however, is believed to be less advantageous.

As to the extreme limits of pressure of the cycle, it may reach 40 or even 60 atmospheres in the combustion chamber; with regard to the inferior limit, that may be the atmospheric pressure or lower, if the escaping gases are discharged in a vacuum. We see here one of the theoretical advantages of gas turbines, which is that expansion may be prolonged well beyond the limits admissible in cylinder motors; thus the lowest point in the diagram can be utilized, and the volume relation may reach as high as 50.

We give herewith a sectional view of the combustion chamber of the Armengaud-Lemale petroleum turbine. This chamber is lined with carborundum; the space between this lining and the steel is filled with a mixture of powdered asbestos and calcined magnesia. The compressed air is introduced through the opening A. The petroleum under pressure flows down the 2 small lateral canals, as shown; these canals are turned upward at the base, and thus throw the oil against the incoming stream of air, in order to

produce a more perfect mixture of the air and gas. Ignition takes place at D by means of a platinum wire heated to incandescence by the current from a storage battery. When the interior lining becomes red hot, as it very soon does, there is no further need of the current.

A turbine of this kind was tested in 1909. The power, measured on a prony brake, was about 25 hp., and the speed was about 20,000 r.p.m. The compressed air was measured by means of a meter; the water for cooling the combustion chamber and the oil were fed under a pressure of 5 kg. (11 lb.). The consumption of air, water and petroleum per horsepower hour was as follows: Air, 9 cu. m. (316 cu. ft.); water, 6.34 kg. (13.8 lb.); petroleum, .6 kg. (1.32 lb.). The average velocity of discharge of the burnt gases was 800 m. (2600 ft.) a second.

In the Lemale turbine the steam from the cooling water is mixed with the burnt gases, reaching the interior of the combustion chamber by means of a circle of openings around its base. This not only adds to the pressure of the gas but also aids in lowering its temperature. In the Kerr turbine the cooling is done by injecting compressed air into the combustion chamber.

In turbines of great power, or when the element of efficiency is of prime consequence, the question of the air compressor is of great importance. Until recent years there have been only piston compressors. In principle these have been quite satisfactory in the production of high pressure with small discharge, but when a large discharge is required their size increases rapidly, and the piston speed attains a value incompatible with the proper working of the machine.

A more advantageous solution of the question has been reached by the rotary multicellular compressor. Mons. Lemale has shown that the mechanical efficiency of such a machine may reach 72 per cent; that is, the theoretical energy produced by the compressed air may be 72 per cent of the energy expended in compressing it. Compressors of this type can be built with dimensions suitable for speeds similar to those of turbines; whence arises the idea of combining these 2 classes of machines in a turbo-compressor group; this arrangement seems likely to give a definite type to the high power turbine of the future.

When it is necessary to give to air a considerable increase of pressure, a great number of compressor disks must be arranged in series, as there is a limit, for mechanical reasons, to the size of the vane wheels and to the speed at which they may be run. In a case in which the question of size is the important point, and where the efficiency of the turbo-motor group is secondary, the Societe Armengaud-Lemale has considered the utilization of tubes or injectors which would be fed by a part of the gases of combustion taken from the combustion chamber itself or from an auxiliary chamber.

According to Mons. Lemale, a Rateau multicellular compressor, running at 4000 r.p.m. will deliver 150,000 cu. ft. of air at a pressure of 11 lb. per sq. in.; the compressor requiring 400 hp. and its efficiency being 70 per cent.

With a compressor delivering air at 13 lb. pressure and an aspirator maintaining a vacuum of 0.2 in. of mercury, we get a consumption in the gas turbine of 300 grams (about ⅔ lb.) of petroleum per horsepower-hour. Such an efficiency is without practical interest for turbines of small size, but becomes interesting when the horsepower reaches into the thousands.

To sum up, the future of the turbine is still uncertain. It would be unreasonable to consider it likely to displace entirely other modes of the production of energy. For small powers turbines are not economical, and it seems unlikely that they will ever be able to compete with motors such as those of the Diesel type. For high powers they compare favorably with steam turbines. The great advantages of the gas turbine are its small size, its great possible unit power, and its light weight for a given power. It seems possible that progress will be made in utilizing further the available heat units of the gas, which of course means an increase in efficiency.

COMPOUND OR NO COMPOUND

By N. Devering

HOWDY!" was the reply to my salutation upon entering the boiler and engine room of a grist mill, while taking a cross-country trip a short time ago.

The engineer (?), from appearances of the engine room and himself, was a lap seam engineer and single riveted too, I should say. He continued to pour oil in and around the oil holes on a dirty engine, picked up the shovel and heaped full and plenty of coal on the fire, shut off the injector and sat down on his friend, the 45-degree backed, home-made chair, saying, "I guess that'l keep her goin' awhile.".

"Yes it ought to," I remarked; "you have certainly given it plenty of everything. How do you like the engineering business?"

"Wall now friend, I like it right smart, when all's goin' well, but here a short while ago, this here old boiler was a cuttin' capers, so's I reckoned I ud cut loose from the job myself, fer I us nearly scared outen my skin fer a couple days."

"What was wrong with your boiler?"

"Wall now to start at the beginnin, friend, I ul tell you. You know we got right smart o' scale in the boiler, an here a while back, one o' them inspector fellers was out here one day, an, by thee Georgetown! if he didn' crawl everywhere raound this boiler but in the steam gage, an' when he got done, he sed as the scale was too thick inside, an' oughter be gotten out o' there, an' if it was out, firin' would be a heap easier, he sed.

"I tole him, I knowed the water was tol'able muddy when the creek riz up at times, but we couldn' stop that, an I tole him I hed heerd bawt some fellers usin' potater peelins an' the like in boilers, but I never had used nothin' o' that sort.

"By Jinks baout a week after that long comes a chap sellin' stuff he called compaound,—a boiler compaound.

"He sed that compaound stuff 'ud take all the scale off the boiler, an' not let her get any more on, if we'd use that stuff.

"Wall now friend I did'n take to his talk because he was one o' them dressed up dandy city fellers, that's all time talkin' boilers, an' feed water, an' economee an' the likes, an' he could talk baout as fast as a chipmunk kin skin a worm fence.

"By'n by he gave me one o' them big long seegars to smoke, an' sed he'd give us nuff compaound stuff for 30 days use, an' it wouldn' cost a cent if we didn' think it the best thing out.

"After givin' Mr. Nyswaner, that owns the mill, one o' them big seegars, an' a lecture on boiler feed

water, he got the right to send a trial of his stuff on here.

"Baout a week later 'long comes a keg o' stuff, looked baout like real thick maple syrup; an' we got a letter tellin' us to use baout 1 qt. of the stuff every day.

"Wall sir, we starts right in to puttin' a quart o' the stuff in with the feed-water every day, an' we kep' that up fer a week, but, by Heck! I couldn' see where firin' was gettin' any ezier, so I reckoned I 'ud have to give her more o' the compaound stuff, an' that if 1 qt. done any good 2 or 3 qts. 'ud do a heap more good.

"So I starts to puttin' in a qt. or 2 extry every day, an' long baout the third day after that the boiler began to act strange like. It seemed like as though the water in the boiler hed gone crazy, it was, a actin' like a cow-boy full o' apple jack.

"Sometimes the top o' the water was in the water bottle, (gage glass) an' sometimes you did'n know where it was. An' the injine begin to squirt water out at the cracks on her fittins, an' when the steam got high an' she popped, the water shot up out o' the pop valve like a rich strike on a oil well.

"An' by thee Georgetown sir, she certainly kept me calcalatin' some, to know what hed set her crazy.

"The injine took to rattlin an' a snortin' too, just as though she was goin' to have fits too.

"Wall stranger I worried that day through but that boiler came nigh unhitching my faculties from their post that day, all right.

"The next day she behaved right tol'able an' so did the injine, but the next day followin,' I happened to rec'olect I had'n give her any compaound the day before, so to make up for lost time I gave her an extry quart or two; an' by the blazin' blue grass broncho if she did'n start to sneeze and slobber all over the place, from the boiler to the steam outlet pipe on the ingine.

I'l tell yer it certainly was a case of crazy horse raound there for a while, an es I hed bin up to town to one o' them spirit meetin's a couple a' nights before that, I commenced to think possibly I was a seein' things unnatural like.

"Well Mr. Nyswaner, the boss, came out an' asked what was the trouble? An' I tole him I did'n know if I hed gone looney, or if the boiler hed got full o' sody-water like they had at the county fair. But she certainly was a dooin' a highland fling just then.

"Mr. Nyswaner got lookin' raound some an' watchin' things awhile, an' all at once he says, 'How much o' that compaound stuff are you usin?'

"'Oh!' says I, 'I'm givin' her a little extry every day to bring off the scale.'

"'Well cut out that stuff fer a while,' says he, 'an' see if she don't act better.'

"Wall sir, I quit the stuff right there, an' do you know that after the followin' day, that old boiler started to go along again just as quiet an well behavin' as the boss' ole family hoss.

"An' you kin chalk it in your hat stranger that there'l be no more boiler compaound stuff used here while I'm ingineerin' here."

I saw readily the cause of this man's trouble; that he did not have the proper quantity of horse sense to use with the boiler compound but I remarked —"Don't you think you were using too much compound?"

"Wall I reckon not,"

"Have you cleaned the boiler since you started to use the compound?"

"No, not yet, but we calcalate to, right soon, as the miller is goin' to fix up the mill some, an' we'l shut down fer a couple o' days."

"How often do you clean the boiler, do you have any regular time for cleaning," I asked.

"Oh! no, we jest clean her out once in a while when we get time, an' mill ain't too busy."

I advised him to clean his boiler as soon as possible, and have a good look inside, to see what things looked like after the spasms it had undergone.

It was about ten days later that I was returning by the same road, and as I neared the engine room door of the grist mill, I saw the engineer standing outside. He was all smiles, and seemed to have something on his mind of which he desired to relieve himself. As I approached him he called out:

"Howdy, Pard! glad to see you. Come an' sit down a spell. I got to tell you what we bin doin' here since you passed up here some time ago."

I sat down on a box while he proceeded to charge the boiler furnace, decorated some parts of the engine with his long spout can, and then occupied his 45-degree throne to begin his startling narrative as follows:—

"You recollect pard baout sayin' we ud orter clean that boiler out?"

"Yes," I replied.

"Wall now we did clean her some I reckon, an' we cleaned, an' cleaned, an' by the—e Georgetown sir, I thought as we 'ud never git done cleanin' ov that boiler."

"Did you get much of anything out of it?"

"Don't git ahead o' the trale pard, wait till we git to that; but, say pard, she was the limit all right. Last week we shut the mill daown, an' I started to clean boiler, an' say,—wall, jes come out here an' see something." With that he led me around the corner of the building and showed me a very large pile of scale.

"Did you get that all out at one time?" I asked,

"You bet your boots we did, an' not much trouble to get it out. It was hangin' and a layin' in there, jes a waitin' to be invited out; an' do you know pard, the boss he went an' writ to the compound man an' tole him all abaout it, an' he writ back sayin, the compaound cut the scale off the boiler, an' also that we were usin' entirely too much of the stuff when we hed the bug-house boiler them couple o' days, an' that we oughter use the stuff a'cordin' to his orders. We're dooin that naow, an' everything's workin' fine, an' we're a'goin' to clean the boiler more often till we have her nice an' clean inside."

He also said that "firin' was'n so tol'able hard as it hed bin."

And I left him a satisfied and happy king of the shovel and oil can domain.

CONSIDERABLE PROGRESS toward actual construction point in a big Oklahoma City, Okla., cotton mill project was made recently, when arrangements for financing the proposition were approved by local promoters. A $5,000,000 bond issue will be made by Western Guaranty & Trust Co., a local corporation with $400,000 paid up capital. Of this amount, it is understood, that $3,500,000 will be floated at once and money used in preliminary work necessary to start company. Other $1,500,000 will be issued as work progresses.

THE SLIDE RULE AS A WIRE TABLE

Finding Resistance, Diameter, Area and Weight for Any No. of Copper Wire with 2 Settings of the Slide

By F. E. Miller

IF it is desired to find the resistance of a copper wire it is customary to look it up in a wire table which it is not always possible to do at once unless frequent use warrants carrying one in your inside pocket. The slide rule is such a handy instrument and so many problems may be worked out on it without the use of tables, etc., that it may be said it generally contains the information needed on the spot.

To Find Resistance

TO find the approximate resistance of any wire it is only necessary to remember that a No. 10 B. & S. copper wire has a resistance of approximately one ohm per thousand feet and a No. 20 B. & S. copper

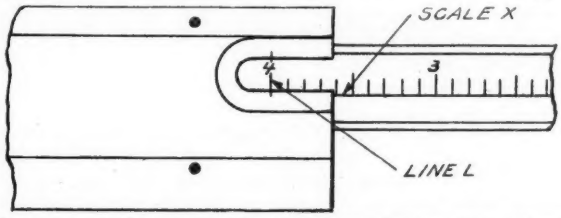


FIG. 1. REVERSE SIDE OF SLIDE AND INDEX LINE SET FOR No. 14 WIRE, OR No. 4.

wire has a resistance of approximately 10 ohms per thousand feet. In many rules the middle scale on the under side of the slide is divided into 10 equal parts. This scale X, Fig. 1, and the lower one, D, on the face of the rule, Fig. 2, are all that will be used.

Suppose it is desired to find the resistance of No. 14 wire: Place the figure 4 on scale X, Fig. 1 directly under the line at L and read scale D under Figure 1 on the slide (Fig. 2). You will note this reads 2.51 ohms or very close to the figure given in resistance tables for a temperature of 75 deg. F.

If the resistance of No. 26 wire is wanted, a similar procedure to the above would be followed, i.e., place the figure on scale X directly under the line at L and read your answer on scale D under Figure 1 on the slide. The answer is 39.8 ohms.

As previously stated, in order to know the place of the decimal point in your answer, you must remember the resistances of No. 20 and No. 10 wire and the rule does the rest.

Other Wire Table Values

WHILE not quite so simple a relation as that just given, the front of the slide rule can be used to find area, weight and resistance when the diameter in mils (thousandths of an inch) is known, or from the setting above given the resistance per 1000 ft. can be found, and from that another setting made which gives the diameter in mils, area in circular mils and in square mils and the weight for 1000 ft.

Take the case of No. 12 wire; by the method given, set 2 on scale X the reverse of the slide at the line, L and on D under 1 on scale C, front side is found 1.586 ohms.

Now set the runner at 1.59 on the lefthand end of scale A, front, and bring 104 of lefthand scale B to the runner. This gives the second setting. Then over righthand index on D will be found on C the diameter in mils, 80.8; under righthand index on A read on B the area in circular mils, 6530; under 7854 on A, read on B the square mils 5130; under 302 on A find on B the weight for 1000 ft., 19.75 lb.

These values are not absolutely accurate but will come within one per cent if the rule is handled carefully.

The setting just given applies to sizes No. 20 to

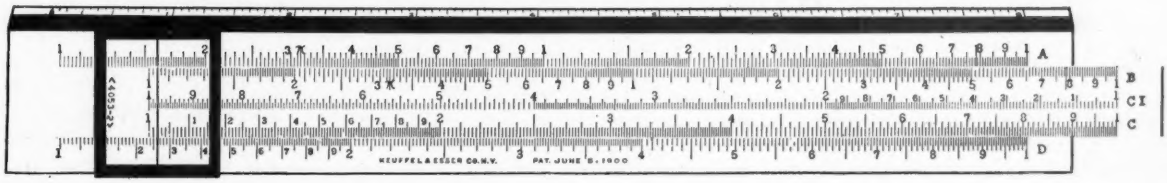


FIG. 3. SETTING OF RULE TO FIND DIAMETER, AREA AND WEIGHT OF No. 12 WIRE

No. 11. From No. 10 to No. 0 the resistance per 1000 ft. is found as given in the first paragraphs. The second setting is as follows: For No. 4 wire, the resistance for 1000 ft. is shown to be 0.251 ohms. Set the runner at 25 on the A scale, lefthand end, and bring 104 of the righthand B scale to the runner.

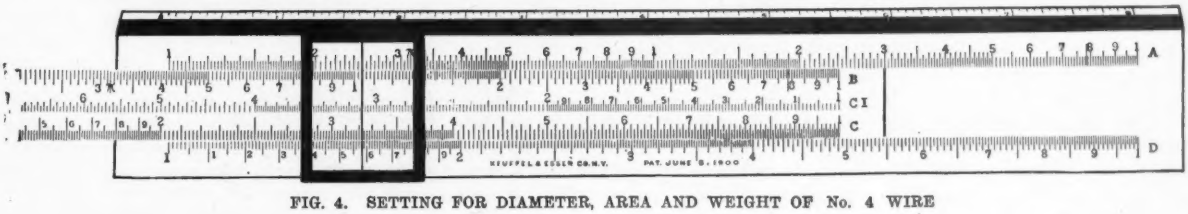


FIG. 4. SETTING FOR DIAMETER, AREA AND WEIGHT OF No. 4 WIRE

Then over the lefthand index of D find on C the diameter in mils, 204.; under the lefthand index of A find on B the circular mils, 41,700; under 7854 on A find on B the square mils, 32,800; and under 302 on A find on B the weight for 1000 ft., 126 lb.

The method may be tabulated thus:

On reverse of rule, scale X, set last figure of wire number on slide to index mark L; on front of rule, under index 1 on C, find resistance in ohms for 1000 ft. on scale D.

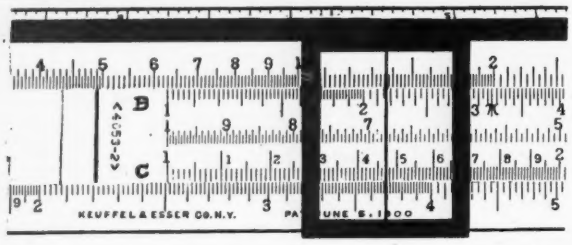


FIG. 2. FRONT OF RULE WITH RESISTANCE FOR NO. 14 WIRE SHOWING ON SCALE D; ALSO FOR No. 4.

Set runner to this resistance value on lefthand of scale A. Set 104 on B to the runner, using lefthand value for wires Nos. 20 to 11, and righthand value for Nos. 10 to 0.

Over index of scale D, read on C diameter in mils; under index of scale A read on B circular mils area; under 7854 on A read on B square mils area; under 302 on A read on B weight for 1000 ft.

For comparison, and to check accuracy in practicing this method of using the rule, the table of values is given in the Practical Reference Tables.

If a wire is in use and its number is not known, measure the diameter in mils, and set this value on scale C at the index 1 on D, using the right index if the value is under 100 mils, and the left index if the value is over 100 mils. Then read area, weight and resistance per 1000 ft., the last being read on scale A, over 104 on B. Then to get the No. of the wire, set the index of scale C at this resistance value on D and read the wire No. on the reverse of slide, scale X under the mark L.

PRACTICAL REFRIGERATING ENGINEERS' ASSOCIATION ANNUAL MEETING

THIS was held in Atlanta, Ga., early in December, and brought together an enthusiastic body of men engaged directly in the operation of refrigerating plants whose object is the betterment of their own work and raising the standards of the calling.

After the usual addresses of welcome and response, Pres. F. L. Ladd spoke of the progress of the Association since its organization in 1910, and of the belief that each plant should be a special study for the engineer in charge with a view to making his product with the greatest possible economy.

He spoke of the change in the attitude of engineers during the last 20 years, comparing the former narrow and selfish spirit with the breadth and helpfulness of the members of the Association and their desire to co-operate for mutual benefit. He emphasized the fact that now-a-days engineers are coming to understand that the more they impart to others of their knowledge, the more they are likely to receive themselves.

Appointment of committees and routine work occupied a large part of the first day of the meeting, and on the 2nd day was taken up the question of attendance at the Third International Congress of Refrigeration to be held in Chicago in September, 1913. There was more or less difference of opinion as to the wisdom of holding the annual meeting of the Practical Refrigerating Engineers in Chicago at that time, and it was finally decided that the Association should hold a special meeting in Chicago in September, and the regular meeting would be held as usual, in December.

The question of providing for auxiliary meetings of local organizations was also taken up, and it was decided to formulate changes in the bylaws to provide for such local meetings.

On Friday afternoon 2 papers were presented—one by Norman Register, on "The Installation, Care and Management of Steam Boilers"; the other by W. M. Francis, on "Steam Boiler Inspection," abstracts of which are given following this report.

W. A. Niall told of a new process for manufacturing ice from raw water, eliminating the possibility of having tannic acid in the ice and making it clear and solid by constant circulation of the water and forcing air through the cans to take out the air held in suspension by the water.

The matter of publishing advance copies of the papers was referred to the Board of Directors as a Publicity Committee, with power to edit and supervise the printing of all papers and matter prepared for publication, and it was specially provided that the association shall not approve or endorse any engineering or commercial enterprise, or allow its imprint or name to be used in commercial work or business, thus confining the activity of the association to professional engineering.

Questions

IN the matter of the question box, the repair of leaky ice cans was taken up, and the opinion was given that either soldering the cans or buying new ones was the only remedy. J. D. Savery stated that the Ice Can Welders, of Chattanooga, had repaired some cans for him at a cost of $1.15 each and with very good success.

In regard to finding the contents of a tank lying on its side, Mr. Savery stated that a good method is to use a meter and, as the tank is filled, read the meter for each inch of rise of the water, thus securing the desired information and marking the tank as one goes along.

Discussing the question of calcium chloride solution for brine, President Ladd stated that during the past year he had had trouble with such brine losing its strength. The chloride is precipitated by ammonia, but he was unable to find any ammonia leakage, and the brine showed no traces of ammonia, nor was ammonia apparently lost from the compressor and coil system.

On this point J. E. Brandt stated that he had the same trouble. The discussion brought out that sometimes a charge of calcium chloride has run for several years without showing deterioration to any ex-

tent, but that recently a charge showed signs of weakening after 3 years' use. Some people claimed that brass fittings affect the brine, but no effect is shown on the fittings.

Mr. Savery suggested that it is a good idea to get an analysis of the kind of chloride which it is proposed to buy, and then send a sample of that received to the Pure Food Station in New York to see if its analysis corresponds with that submitted in the proposal.

Meeting Place and Officers

TAKING up the meeting place for 1913, the decision was in favor of Hot Springs, Ark., and the time the first week in December.

New members were then elected as follows:—Regular members, C. A. Banks, Orange, Tex.; L. E. Bennett, Columbus, Miss.; T. P. Wortham, Big Springs, Tex.; Bennett Storie, King Fisher, Okla.; Jas. E. Rule, Long View, Tex.; Sam B. Bayliss, Birmingham, Ala.; W. A. Owen, Johnson City, Tenn.; Isham W. Mann, Dawson, Ga.; W. W. Hughes, Fitzgerald, Ga.; John Hebel, Shreveport, La. Associate members, Carbondale Machine Co., Carbondale, Pa.; E. L. Dormindy, Fitzgerald, Ga. Honorary members, Col. Wm. J. Rushton, Birmingham, Ala.; W. M. Francis, Atlanta, Ga.; W. H. Ross, New York, N. Y.; J. Harry Howell, Nashville, Tenn.; Prof. M. K. Matthewson, Atlanta, Ga.

The report of the nominating committee was received and the officers were elected as follows:—President, Carl Nessler, Texas City, Tex.; Vice President, J. Higginbotham, Scranton, Miss.; Secretary and Treasurer, J. B. Embrey, Shreveport, La. Board of Directors, D. L. Gilbert, Dallas, Tex.; Board of Examiners, W. A. Owen, Johnson City, Tenn.

Resolutions were then passed, thanking the Entertainment Committee, manufacturers and their representatives for the pleasant and profitable meeting in Atlanta, and the resolution on the death of Victor H. Becker, of Chicago, was ordered spread on the records.

MANAGEMENT OF STEAM BOILERS

Savings from Removing Scale, Careful Firing, Danger from Incorrect Water Columns and Bad Blowoffs

By Norman Register

EVEN while we are hearing so much relative to the economy of gas and electric plants, there is constant and growing demand for more power from steam, and the boiler, as the source of this power, cannot have too much attention paid to its construction, installation and care.

The boiler room and its contents have been likened to the stomach of the human body in relative importance to the power plant. The health of the plant is usually dependent entirely on the condition of the boiler room and its contents, and the financial well-being of the plant is largely regulated by the economy of the boiler end. With any type of boiler, there is little hope of satisfactory results unless some engineering skill is exercised, and one of the main points is keeping the boiler clean, free from scale and mud, with all openings clear.

Loss from Scale

RECENT tests at the University of Illinois show that a hard scale 1/50 in. thick, causes a loss of 9.4 per cent in heat transmitted to the water; while 1/16 in. scale causes a loss of 12.4 per cent, so that time and money are well expended in keeping the boiler clean.

It is a lamentable fact that in many small plants no pay is allowed for cleaning boilers, and where the plant runs all the week, this is done only on Sundays. It is easy to surmise that unless the engineer has an unusual amount of energy and pride, the boiler is likely to suffer from lack of care, and the owner's bank account from increased fuel bills.

Clean Boiler Room and Clean Cut Firing

IT seems the general custom that, as coal is kept in the boiler room and ashes and soot are sometimes present, anything which cannot be fittingly put elsewhere is consigned to the boiler room. With a little effort, time can easily be found to keep the boiler room floor swept, the boiler fronts cleaned, and ashes and soot swept from the tops of boilers, all which will contribute to the appearance and comfort of this part of the plant.

It will also assist in securing an intelligent and industrious fireman, who is not only a prize but one of the most economical adjuncts to the power plant. Just to illustrate:—Some 12 years ago, taking charge of a large steam plant that had been in operation some 8 months, consisting of 3 300-hp. fire-tube boilers with underfeed stokers and forced draft, only ⅔ of the load could be carried, and the fireman had to have help when cleaning fires. The fuel waste was such that I feared for my own position. Putting on a young man who was willing to learn new ways, he did not work one-third as hard as the old fireman and the plant could go right along when fully loaded with only 2 of the boilers in use. I figured that the saving in cost of operation was a little under $18 a day, and the wages paid the 2 firemen were the same.

Hot Feedwater

NEXT to an intelligent fireman, a good feed-water heater is of importance. When it performs its functions properly, it is a great fuel saver, but if neglected may become wasteful and a source of annoyance as well as dangerous to the boiler.

One engineer made a saving in the fuel bill of $200 a month over his predecessor, simply by cutting out the heater and spending about 10 hours placing it in proper working condition, thus raising the feed-water temperature from 160 deg. up to 210 deg.

Setting and Suspending

IN setting, the best grade of fire brick and fire clay, in the hands of a careful workman, will prove a paying investment; not only will work stand up longer, but a poor furnace job is a source of loss from the start, increasing the fuel consumption and injuring the boiler by the cold air admitted.

Horizontal return tubular boilers should be suspended so that they are free to expand and contract. Use strong I-beams or channel irons resting on iron columns, set independent of the brick work. If in a battery of boilers it is necessary to use intermediate columns, leave an air space around them in the side walls, as if set without such air space, they are likely to be burned off at the fire line.

Water Where it Belongs

OFTEN I have seen 3 to 12-in. pipe with from 6 in. to 6 ft. of entrapped water of condensation, due to the wrong placing of shutoff valves. When steam is turned into such a pipe, the water frequently surges

so that it will be thrown against the fittings and cause breakage. There is real danger in such water pockets, and great damage and loss of life can be traced to such defects.

In cutting in boilers, there is hazard, if great difference of pressure exists between the incoming boiler and the main. The pressure should be brought as near as possible to that in the main before the valve is opened. Gage cocks should be properly located so that they will at all times be in good working order, and provision should be made for cleaning and blowing out the water column connections.

I recall visiting a new boiler room where all fittings had been supplied properly and the erection had been done by a local pipe fitter. He placed the short nipple at the bottom of the water column instead of at the top, so that the bottom gage cock was some 13 in. below the top of the tubes, and when carrying 1½ gages of water, the top row of tubes was bare. Fortunately, although one of the boilers was being operated at the time of the discovery, only low-pressure had been used and no serious damage had been done.

Be Good to the Blowoff

ANOTHER important feature is the setting of the blowoff pipe. Fifteen per cent of boiler accidents are caused by improperly connected or defective blowoff pipes. I recall several instances where this pipe was placed in the front head of the boiler, and others where the blowoff pipe was in the rear head, several inches above the bottom shell; and I remember one return tubular boiler where the blowoff pipe was placed in the fire sheet, 8 ft. from the rear head.

Pipes are found from 1½ to 6 in. diameter, and often fitted with cast-iron or brass elbows and flanges exposed to the hot gases. I believe that all authorities agree that such fittings should be of steel when exposed to the direct action of the fire, and that the entire pipe should be protected with good nonconducting material.

Blowoff pipes should be attached to the fire sheet, as near the rear head as possible, so as to drain from the lowest point, and I cannot imagine a case necessitating a pipe over 2½ in. in diameter.

Opening and closing a blowoff valve should be done slowly and cautiously; yanking the blowoff open or closed is dangerous. No valve about a steam plant should be so handled except in times of great emergency. Imagine a 2½-in. blowoff pipe on a boiler carrying 125 lb. pressure; the area of the pipe is 4.9 in., which at 125 lb. gives 612.5 lb. pressure, which is about the shock on the pipe when the blowoff valve is yanked shut. How many engineers would stand by and see the blowoff pipe hit with a sledge hammer when the boiler is carrying 125 lb. steam pressure? But where is the difference between the 2 operations?

THE REAL ESTATE FIRM of Stine & Kendric of San Francisco, Cal., has announced the opening for sale of 14,000 acres of land lying along the Sacramento river. This body of land, known as the Tubbs-Tuttle ranch, lies in Colusa and Yolo counties, the southern portion of which is about 15 miles north of Woodland, and about 30 miles from Sacramento. It possesses 21 miles of frontage on the Sacramento river, and has a width of 1½ miles, extending from the river; in fact, it includes all of the Sacramento river bank which controls the shipping facilities in the entire district No. 108.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

Results of Errors and How to Avoid Making Them

MY DEAR SON DONALD:—

We received your very welcome letter of a few days ago in due time and will answer it at once as there are many things in it that prompt me to take up the pen. Donny, boy, I am more than glad to see you come right out open and above board and say that you fell down.

Of course there is no one that regrets your misfortune more than I do and I am really sorry that you got mixed up over a little thing like a check valve. There are few persons in this world who get very far but that they make some kind of a mis-cue, only some of the mistakes are more important than others. In your case, the monetary loss was trivial. It all simmered down to the fact that the Chief depended on you to do one certain thing that he had perfected in his mind after a great deal of thought, and you simply slipped up on the thing owing to the extreme simplicity of it.

No one makes a mistake, no matter how trivial, but that it leaves a shadow of doubt on the part of the one above, as to your fitness to do a job without having some one to supervise things.

The oftener mistakes are made, the greater is the shadow of doubt till finally there comes a time when the boss says, "Well, he is nothing but a commonplace man, one who reaches his limit on the end of a long handled shovel. I guess that I will give this particular job to the other fellow. He doesn't fall down so often."

Still, my son, even the best of us slip a cog some time or other and some of us are of the caliber to live it down quicker than others and regain the confidence of our superiors.

Now, you say that "confession is good for the soul." This reminds me of something that I want to say in passing that will be of interest. There are many persons that are in positions to make mistakes, even big ones, and it will be soon forgotten, but there are others who can make but one and that one is the last.

How often you read in the paper of the train dispatcher who tries to make 2 trains pass on the same track or something like that. Only one mistake and then it is all off with him. The man who mixes the ingredients of which dynamite and similar explosives are made, has at hand the valves controlling the different liquids and if he gets to day-dreaming, the only way the world finds it out is by the hole in the ground where he used to work, the rain of falling debris and the deafening explosions.

Suppose that check valve which you reversed, was, say, on the discharge line of a new injector which you had installed as an emergency in case the feed pump gave out. Suppose, that, while you were gathering up the tools and surveying the job, the pump **did** give out,—as it did with me once within 5 minutes after I got the new injector connected up?

Then, when the fires are banked, or dropped into the ash pit, the engines stopped and the Super comes around to find out WHY,—how long will the fellow last that put the check valve in the feed line wrong end to? Be broad and liberal in your thoughts and ideas and you will be broad and liberal in your actions.

When you go about a new task, look at it from every point of view and ask yourself, "What will happen if I do this wrong, or that wrong, or make a mistake here or there?"

Now, you are in the repair gang and there is no place where a man can get injured with so little trouble as there. You are all about the works, doing tasks in all manner of places and under all manner of conditions. Here is something that I want you to do. Start right in now and cultivate the habit of making it sort of second nature to look out for yourself first of all, and it will save you lots of trouble.

That does not mean that you should be foolish enough not to do anything for fear of getting hurt. If you are, for instance, walking on planks laid over a staging or laid temporarily on false work, or something like that, it is easy to look ahead and see if you are walking on a solid plank, or one that will drop you into the cellar when you walk far enough on it.

In working on staging such as you have to do sometimes in repair work, look where you are going to land if the wrench slips and it may save the doctor lots of trouble patching you up in the hospital.

On overhead pipe work, it is easy to get a bad fall if the wrench slips and easy to prevent injury in this way by looking how to catch yourself even if it does. Moving heavy machinery is the same way. A man's toes were not made to drop rollers and timbers on and when you start to use a sledge it will save you lots of trouble in the long run to see that you are not going to get tangled up in a guy line with it or break the ribs of some one working behind you.

(To be continued.)

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

The Effect of the Electric Current on Re-enforced Concrete*

By J. H. Blakey

DURING the last few years there have been published at various times alarming accounts of the destructive effects of the electric current on cement and re-enforced concrete. These accounts are based entirely upon the researches of M. A. Knudson, the results of which, published in 1908, were used as a basis for most unreasonable exaggerations and generalizations. Some writers went so far even as to say that blocks of concrete, after being submitted for a certain length of time to the action of currents of quite feeble strength, would undergo disintegration sufficient to enable them to be cut with a knife!

Now the review, "Die Bauwelt," has just made, among the experts and technical men throughout Germany, an inquiry for the purpose of determining whether insufficiently insulated electrical canalizations will have prejudicial effects upon structures of re-enforced concrete. The result of this inquiry is that up to the time of writing, not a single case has been brought to light in which the electric current has had any injurious effect upon a building or on any part of it. The data gathered relate to many central stations for lighting and motor power, as well as masts and private houses of concrete. Even water works, which on account of their exposed situation and the water they contain, would be especially subject to injury, have never presented the smallest trace of damage to the concrete, due to electrolytic action.

In order to explain this disagreement with the results of Knudson and other writers, let us recall briefly his experiments and those of some others. Of the blocks of cement submitted to strong pressure under soft water and sea water, those which had been kept under soft water were found to be more easily damaged by electric currents than those which had been in sea water. On the other hand, experiments made in 1910 by M. Gehler, indicate that the prolonged action of a current exerts a drying effect not only on concrete blocks kept in water but also on those which have been protected from moisture. Tamped concrete, however, does not undergo any sensible reduction of its resistance to pressure. M. Gehler draws attention to the fact that this evaporation of moisture under the action of the electric current takes place only under conditions very much exaggerated in comparison with those of actual practice. In the richer concrete mixtures the drying is more rapid than in poorer mixtures; these latter present a higher initial resistance than the blocks of richer mixture.

Matters are somewhat different in the case of re-enforced concrete. Experiments on this have shown that under the action of the electric current there have been formed fissures in the neighborhood of positive electrodes; the surfaces of armatures forming the positive pole have been entirely covered with rust, while the negative electrodes in iron have remained perfectly smooth and the concrete absolutely intact. The fact that the fissuring in the concrete is due entirely to the rust of the positive electrodes is proven by the fact that when iron electrodes are replaced by brass it is impossible to produce any injury to the concrete even with the strongest currents. Similar results have been recently obtained in the experiments of Mons. U. J. Nicholas.

Incidentally, these experiments have made us understand that concrete must be considered not as an insulator but as a conductor of the second order. There exists in fact a well defined relation between the resistance and the temperature of the block. In proportion as the temparature increases the resistance diminishes, and vice versa, which is the exact opposite of what is true with regard to other electrical conductors.

If these facts and the rust on the positive electrodes lead us to suspect the existence of chemical decomposition resulting from the passage of the electric current across the concrete, it can nevertheless be affirmed that experience has not yet given any evidence of destructive action sufficient to be appreciable.

* Translated from the "Revue Scientifique" of Oct. 5 1912.

At the meeting of the American Society of Agricultural Engineers, Eugene Becker brought out the fact that explosive mixtures of gas and air are formed as follows: Gasoline vapor 2 to 5 per cent, air 98 to 95 per cent; acetylene 2 to 49 per cent, air 98 to 51 per cent; blow-gas 4 to 8 per cent, air 96 to 92 per cent; which shows why great care must be exercised in handling acetylene gas to avoid explosions.

At the same meeting, standard rules were adopted for scoring in tractor contests, and the Society announced itself as ready to supervise such contests. C. F. Hirshfeld explained clearly in a paper illustrated by lantern slides the Principles of the Fuel Oil Engines, the carburetion of fuels and beneficial effect of water when injected in connection with the heavier oils.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

SLOTTING THE COMMUTATOR

IN our power plant of 4 direct-current generators, we have been having a great deal of trouble with the commutators sparking after the machines have been run for a number of hours.

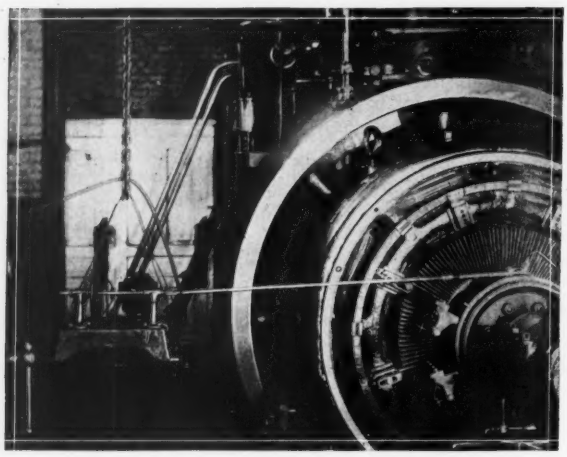


FIG. 1. OUTFIT FOR SLOTTING COMMUTATOR

It had been necessary to clean the commutators off after every turn with a block that just fitted the circumference of the commutator on which was tacked several sheets of sand paper.

After hearing many reports of the good results of slotting or under cutting the mica. we decided to try it. At first we attempted to do it with a hack saw blade; but soon found the mica so hard that we could not make much progress. We then secured one of the slotting machines with a circular saw. We were at first up against it for proper power to drive the saw; we tried a 15-in. fan motor but that was not strong enough; then we took a ¼-hp. high speed motor, that was too fast, it running 3200 r.p.m. which vibrated the machine too much.

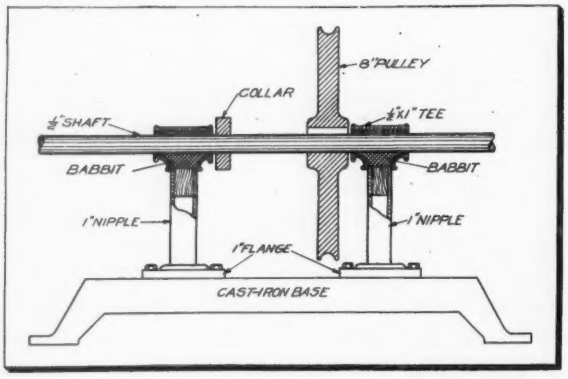


FIG. 2. SHAFTING AND WHEEL FOR REDUCING SPEED

I then rigged up the reducing outfit, as shown in the photograph. I happened to have a small cast-iron base plate. I set the motor on one end and made 2 post bearings out of pipe fittings for the jack shaft. These were made by taking 2 1-in. floor flanges, screwing into them 2 1 by 4-in. nipples, on top of the nipples I screwed 2 ½ by 1-in. tees, in 1 end of each tee a ½ by ¼-in. bushing was screwed and these drilled out to ½-in. diameter. A piece of ½-in. shafting was put through the tees, the bushing ends being on the outside. The 2 posts were then lined up on the plate with the shaft parallel with the motor shaft. Two small holes were drilled in the top of the tees and then the tees were filled with babbit (wooden plugs were driven in the top of the 1-in. nipples so that they would not fill with babbit). After the bearings were babbited the shaft was drawn out and the bearings scraped so that the shaft fitted freely.

A 2-in. grooved pulley was put on the motor shaft and an 8-in. pulley on the driving shaft. This reduced the speed to about 800 r.p.m. and turned the saw about the right speed, although 1200 r.p.m. is claimed to be not too fast.

This motor outfit was then suspended by a chain from a clamp in the ceiling so that it would swing. This swinging allowed the cutting of from 6 to 12 segments without moving the commutator.

On a 75 kw. with 145 segments the work was done in about 3 hr. Since the machines have been slotted we have not had any further trouble with sparking; and when one is shut down the slots are always found to be clean, the mica can plainly be seen in the bottom. The centrifugal force of the commutator throws out any particles that may get into the slots.

L. M. Johnson.

STARTING A CORLISS ENGINE

MR. SCHINDLER in the Dec. 1 issue, and Mr. McGerry in the Dec. 15 issue of Practical Engineer, both point out the same error in an article by the writer which appeared in the issue of Oct. 15, in regard to the manner of starting and stopping a Corliss engine.

These comments are received in the same friendly spirit which prompted the writers to mention the error, and am glad to thank both gentlemen for calling my attention to the fact that there is usually a safety stop in connection with the governor of most Corliss engines which requires manipulation by the engineer, either when starting or stopping the engine, so as to make it operative and prevent excessive speed in case of breaking of the governor belt.

It is over 12 yr., however, since the writer has operated a Corliss engine which required attention at either starting or stopping in order to make the safety

appliance operative, and he feels he is, in a measure, excusable for the omission.

Most Corliss engines made prior to 15 yr. ago required hand manipulation on the part of the engineer, either starting or stopping. Practically all of the later designs, however, are automatic in this respect, in that the governor is held in the running position at all times, usually by an idler on the governor belt, and should the belt break, it will permit the idler to drop by gravity, when it will remove the device which has supported the governor in position, thus bringing the safety cams into position where they will prevent the engagement of the steam valve gear.

Some engines have a reach rod of small size extending from the governor to the throttle valve stem, on which there is a cone located in such a manner that when the valve is opened and the engine started, it permits the support to be removed from under the governor as soon as the engine comes up to speed, and when the throttle is closed, this support is restored by the cone acting on the end of the reach rod mentioned above.

There is a steam controlled automatic safety device still used on some Corliss engines in which steam from the steam chest of the engine acts on a small piston in such a manner as to remove the support under the governor as soon as the engine comes up to speed, and restores it as soon as the throttle is closed. Thus, if the governor becomes deranged so as to cause it to stop, it will drop far enough (the support being removed) to bring the safety cams into play, preventing the engagement of the valve gear.

The writer fully realizes that the lack of this information in the original reply to R. D., might leave some beginner in Corliss engine work in a very embarrassing position when taking charge of such an engine for the first time. In fact, it might puzzle an old timer if he had not been used to the hand-manipulated device for a number of years, and I am glad to see these matters brought up in the columns of Practical Engineer, for it is this interchange of experience which broadens our ideas. G. H. Wallace.

WHAT CAUSED BROKEN FLYWHEEL

FROM Chas A. Cooper's description of the flywheel accident it seems quite possible that the engine may have run away, although if it did I wonder why some of the men did not notice the increased speed of the engine or machinery around the mill..

Mr. Cooper does not say whether there was any evidence of damage or scars in the cylinder, or missing follower bolts. If a broken follower bolt was the cause of the broken wheel the cylinder head and piston would surely show some spot where the loose bolt was caught between the piston and cylinder head. I have in mind a Corliss engine in which several follower bolts were broken at different times, some of them went through the exhaust valve, one broke a piece out of the exhaust valve, another was punched through the cylinder head, and the last one broke the cylinder head, piston, piston rod and crosshead, but no damage was done to the flywheel. In a slide valve engine I do not see how the bolt could get away, unless possibly into the drip pipe, without doing some damage to the piston and cylinder head.

I am of the opinion that a dose of water in the cylinder caused the damage to the wheel rather than a broken follower bolt, because the strain from a dose of water would act on the entire area of the head and piston, possibly not breaking either but throwing a much greater strain on the flywheel than the broken follower bolt would as it would only strike the head on a small area and would be more likely to spring or break the head or piston.

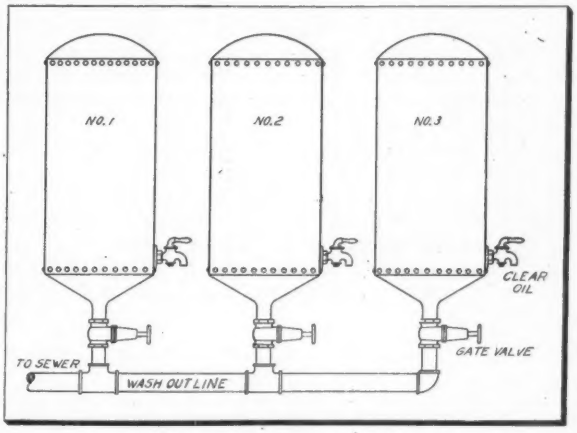
When running at a speed of 130 r.p.m. the rim speed of the wheel would be about 4900 ft. per min, while the safe rim speed of a cast-iron wheel is usually taken as about 6000 ft. per min., and that with a wide factor of safety, in which case the engine would have to run something over 160 r.p.m., to get beyond this safe limit.

The condition of the governing mechanism ought to throw some light on the subject as to whether excessive speed caused the accident.

J. C. Hawkins.

OIL SETTLING TANKS

ACCOMPANYING is a sketch of oil settling tanks I installed in the plant where I am engineer. The company did not want to go to the expense of buying a filtering plant, so I had a tinner make 3 galvanized tanks, 26 by 30 in. They hold about 60 gal. of oil, so I put the oil in one tank at a time until I get them



SETTLING TANKS FOR USED OIL

all filled up, then I empty the first one that was filled, and the oil, when it comes out of the tank, is just as clear and clean as when taken out of the barrel in the first place.

As the bottom of the tanks are made in cone shape, all dirt and water settle there and are drawn off through the waste pipe to sewer. A. W. Wolfe.

CHECK VALVE PROBLEM

I HAVE carefully examined the article by Wm. F. Fischer, October 1, 1912 issue of Practical Engineer, treating of check-valve problem, page 971, given by H. C., August 1 issue. Mr. Fischer does not arrive at the correct results as I see them.

Mr. Fischer, also H. C., figures on a difference in the effective area of the opposite sides of the check valve disk, whereas in fact, there is not any difference in the effective area of the opposite sides of the disk, no matter what the shape of the disk may be. There is always a film of water between the disk and its seat, and the pressure of this film of water is that of the highest pressure in the line, whether over or under the chack valve disk. If we have a check valve disk, the area of the boiler side of which is 3.1416 sq. in. or 2 in. in diameter and the pump side of which has a

diameter of 1½ in., as shown in Fig. 2, there will always be an area of 1.3745 sq. in. against which pressure operates, tending to lift the disk. Whether there is pressure exerted over or under the disk, it makes no difference; then when pressure is exerted, say on the pump side of the check valve disk, the area of the 1½-in. circular bottom of the disk is added to that of the sides, which is supposed to make contact with the seat of the valve. The area of the 1½-in. portion is $1\frac{1}{2}^2 \times 0.7854 = 1.7671$ sq. in., which added to 1.3745, gives 3.1416 sq. in., same as that of the top portion of

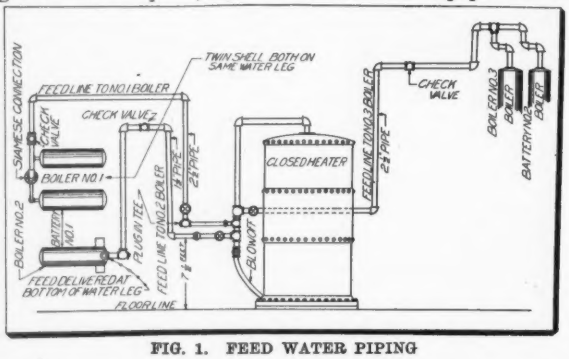


FIG. 1. FEED WATER PIPING

the disk. If the surfaces which are supposed to make contact with each other actually did make contact, they would stick together as though they had been thus glued together.

And now we shall speak about our experiments with our feed lines, of which Fig. 1 is a sketch showing fittings and all. I attached a steam gage to the air chamber of the pump and it showed a pressure of 145 lb. at the pump when delivering water to No. 1 boiler only. With No. 1 boiler shut off and the pump delivering water to Boiler No. 2 only, through 10 ells,

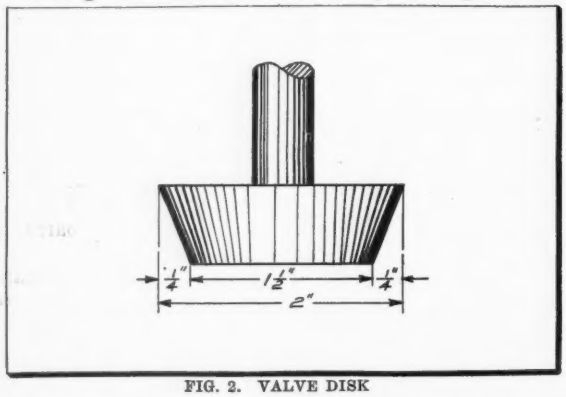


FIG. 2. VALVE DISK

2 tees, 2 check valves, 1 globe valve, 8-ft. head of water, 40 ft. of 1½-in. piping, we had a pressure at the pump of 143 lb. boiler pressure in each case being 135 lb.

Boilers No. 3 are out of service just now and I could not try them out, but the gage which we have on the header always shows a pressure of 18 lb. above boiler pressure in the heater when pumping water to them through the 8 ells, 2 tees, 1 check valve, 1 globe valve, 12-ft. head of water and 74 ft. of 2½-in. piping, as represented in sketch.

This satisfies me that a properly working check doesn't appreciably impede the flow of water through a pipe.

If either Mr. Fischer or H. C.'s figures were correct in the matter of the difference in pressure required at the pump to lift a check valve, we would not be able to pump water into our boilers at all, because we have 2 check valves on the line between the pump delivery valves and the boilers, plus the pump delivery valves which are in reality practically the same as a check valve (heavier if anything), thus the pumps we have would have to work against a pressure of 135 lb. boiler pressure plus $3 \times 44 = 267$ lb., and the design of our pumps would not permit either of them to move.

Thos. C. Robinson.

(Mr. Robinson assumes that the film of water between the disk and seat of the valve communicates pressure between the 2 sides of the disk. As a matter of fact, this is not so, except when the valve is off its seat; if it were the water would flow back through the valve and it would be useless. He states further that he put his test gage on the air chamber of the pump, which does not give him absolute results, only average pressures, as the air is elastic. If he will take off his air chamber and attach his gage directly to the pump discharge chamber, he will notice considerable variation in pressure, that is, if the design of the pump is such that it will allow the check valve to close between strokes, if, however, he gets a continuous flow, the valve disk is off its seat all the time and, of course, the pressures on each side are practically equal. The pressure to lift the valve from its seat is that calculated by Mr. Fischer, as the pump must be able to deliver that pressure.—Editor.)

Concerning check valve problem discussed by Messrs. Reynolds and Guttormsen in Dec. 1 issue, I think both have neglected to consider all the forces acting on the check, also both are mistaken in stating that the area exposed to pump pressure is immaterial.

Assume areas of 1 sq. in. and 2 sq. in. respectively and pressure above check as 100 lb., also neglect weight of valve and friction of pipe. When valve is on the seat and 1 sq. in. area exposed to pump pressure, 200 lb. pressure per square inch will be required. I balance 100 lb. on top, a slight excess momentarily in addition to raise check, and, as soon as this takes place, 100 lb. plus the amount necessary to overcome weight of valve will keep it off the seat, the pump pressure then being exerted on 2 sq. in., same as top area.

Part of this power being furnished by the water may account for the slight excess pressure shown by H. C.'s gage.

Mr. Reynolds' diagram can be considered as the steam and water pistons. Would not 100 lb. exerted on the large end balance 200 lb. on the smaller? Or, conversely, were the areas reversed, that is steam applied to small area, would it not require over 200 lb. to pump against 100 lb.? Harry H. Yates.

In practice and with the ordinary gages, we would probably fail to see much, if any, difference in the reading of the 2 gages, for this reason: The pressure builds up under the valve and lifts it, the water rushes between the valve and its seat, thus equalizing the pressure on both sides—neglecting that necessary to overcome the weight of the valve—so quickly that the ordinary gage would fail to register intelligently any difference.

If, however, the pressure be allowed to build up slowly, the gages will show a difference in pressure depending on the area of the valve and opening through the seat.

Mr. Reynolds says the valve is balanced when that part over the opening has a pressure of 100 lb. on

each side, and that part over the seat has a load of 100 lb. acting downward against 100 lb. acting upward by the seat. Here is where he is in error, for the seat, instead of acting upward, is simply resisting or supporting the downward thrust of the valve. This resisting action of the seat must not be confounded with pressure of the liquid. The valve can be in a balanced state only when the pressure is equal on all the surface of both sides, or to be correct, when the pressure is the same on all its surfaces, which includes the edges also. Before there can be any pressure between the seat and the valve, the valve must first lift or leave the seat. To do this the pressure in the opening must first build up sufficiently to overcome the total downward pressure. In order for the valve to close the opening, it must of necessity have a greater area than the opening. Therefore, to lift the valve the pressure in the opening must be greater per square inch than that acting above, in order to compensate for the reduced area of the valve against which it can act. Of course this increased pressure exists only for an instant, for just as the valve moves the 2 pressures equalize.

The writer has tried this out, but a relief valve on an exhaust pipe was used in lieu of a check valve, and found the pressure on the under side to be greater in every instance, depending on the amount of the valve coming in contact with the seat as compared to that covering the opening through the seat.

Jos. Stewart.

Regarding the errors in "Check Valve Problems," page 1193, Dec. 1 issue of Practical Engineer, would like to say that my idea of the matter is as follows:

Referring to the sketch and assuming that the upper side of valve disk has an area of 2 sq. in. and the lower side 1 sq. in., with a perfectly tight steam fit, I would think that the pressures acting on each side must be equal to balance the valve, disregarding weight of valve.

If a pressure of, say, 100 lb. per sq. in is acting on upper side, a total of 200 lb. is bearing down, an upward pressure of 200 lb. is required to balance and in this case it would be 200 lb. on 1 sq. in. or double the square inch pressure acting from above..

Chas. M. Green.

Mr. Reynolds is right as far as the gages on both sides of check is concerned; they will register practically the same. This seems queer, for the load on any valve or piston is the pressure per square inch multiplied by the area, and as the area on the boiler side of this valve is 2 sq. in. and the area on the pump side is 1 sq. in. with the valve on its seat, the pressure on the pump side would have to be 200 lb. plus the weight of the valve. If a compressible gas were doing the lifting, this pressure would show on the gage, but as water is being pumped the valve is opened by a blow directly on the valve disk, caused by the inertia of water and the gage does not indicate this pressure. If there were no reservoir partly filled with a compressible fluid in front of the valve, or if the inertia were spent in some other way than lifting the disk, the valve would remain closed until the pressure throughout the entire pipe became sufficient to unbalance the disk on the under side. W. A. Griswold.

I make no allowance for friction, etc, having in mind only overcoming the force of the boiler pressure of 100 lb. per sq. in. It is assumed that in addition to this boiler pressure the pump will overcome all forces tending to retard the free flow of the water.

The areas of circles are to each other as the squares of their diameters, so the problem is worked in this way: $\frac{1\frac{7}{8}^2 \times 100}{1\ 9/16^2} = 15/8 \times 15/8 \times 100 \times 16/25 \times 16/25 = 144$, which means, the pump will have to bring the pressure up to 144 lb. per sq. in. before the valve will open. The disk is now in a state of equilibrium or balance, ready to open upon the slightest forward movement of the pump. The moment the valve opens the conditions are changed. The pressure is no longer confined to the restricted area of the opening in the seat, but is distributed over the entire area of that side of the disk and as long as the pump continues to cause the water to flow through the valve, the disk will be "floating," as it were, the pressure per square inch will be practically the same on both sides of the valve and will remain so while the valve is open.

Two gages, one placed on either side of the valve, will approximately register the same and altogether likely will vary but little during continued operation of the pump because, under good working conditions, the period of time the valve is closed is so short, and, owing to the noncompressible nature of water, the movement of the pump necessary to open the valve is so slight, the gage has not time to respond unless it be by a mere wiggle.

Mr. Reynolds' reasoning is wrong in assuming that the area around the seat opening which supports the disk will assist in lifting it off the seat. No more will it do this than the floor will help you in lifting the 25-pound casting. W. N. H.

Mr. Guttormsen says that the area exposed to the feed pump is the only area to be considered and that the outside diameter could be 2 in. or more and the same pressure from the pump would lift the check. In this he is mistaken, unless he assumes that the check is always lifted slightly off its seat and allows a film of water to remain between the valve and seat. Assuming the valve to be perfectly tight when seated, the area times pressure on one side equals area times pressure on the other side as explained by Mr. Fischer in a previous issue. Besides, I do not see how Mr. Guttormsen gets 101.5 by dividing 195.6 by 192.6. My solution of this division gives me 1.015.

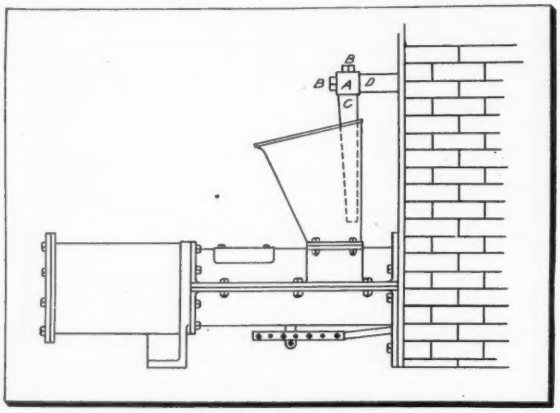
Mr. Reynolds has fallen into the same error. According to him the valve seat is acting upwards with a force equal to 200 lb. True it is in one sense, but the seat is simply holding it there and is not doing any lifting. The lifting has to be done by the pressure from the pump. Again he says that if the hole through the seat were only ⅛ in. in diameter, that it would make no appreciable difference in the pressure required to lift the valve. In this he is in error. It would make a difference in proportion to the area of the hole through the seat. Frederick M. Perras.

THE UTAH-IDAHO SUGAR CO. is busied getting everything in readiness to commence active work of construction of the new sugar factory in Payson, Utah. They have purchased over 100 acres of land surrounding the site where the factory will be built. It is almost impossible for them to rent houses here for their workmen and the company will erect about 15 houses near the factory site. Active work will commence soon.

Payson seems to have taken on a new life since it has been definitely settled that the factory will be in operation by next September. A number of merchants are already considering putting in larger stocks and larger buildings.

DEVICE FOR REMOVING HOPPER GAS

ENCLOSED drawing is of an underfeed stoker with attachment I devised to take away the hopper gas which is frequently formed and fills the boiler room. A is a 3-in. cross; B, B are plugs to clean out both ways, C is a 3-in. pipe flattened on one end and extends inside hopper to about 2 in. from ram; D is a

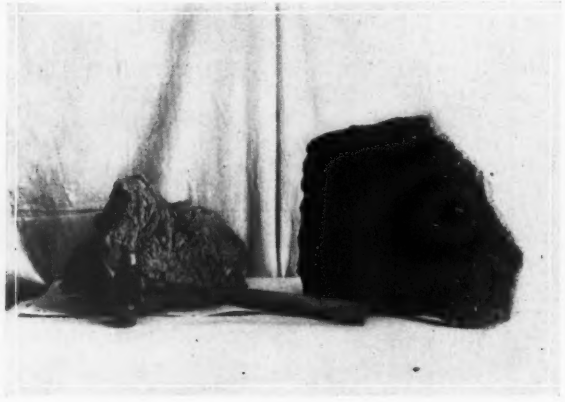


METHOD OF REMOVING HOPPER GAS

short 3-in. pipe through boiler front over the fire. The draft draws the gas which escapes through the ram case over the fire where it is burnt. The size of pipe to be used depends upon the amount of gas which forms in the hopper. W. A. Jones.

SPECIMENS OF BOILER SCALE

TWO specimens of boiler scale are shown in the accompanying photograph. That to the right was taken from a boiler at a coal mine in Kentucky and is flat being held on edge, it is 2 in. thick in the center and tapers down to 5/8 in. at the edge. The flues in this boiler collapsed, probably due to scale.



SOME SCALE FROM POWER BOILERS

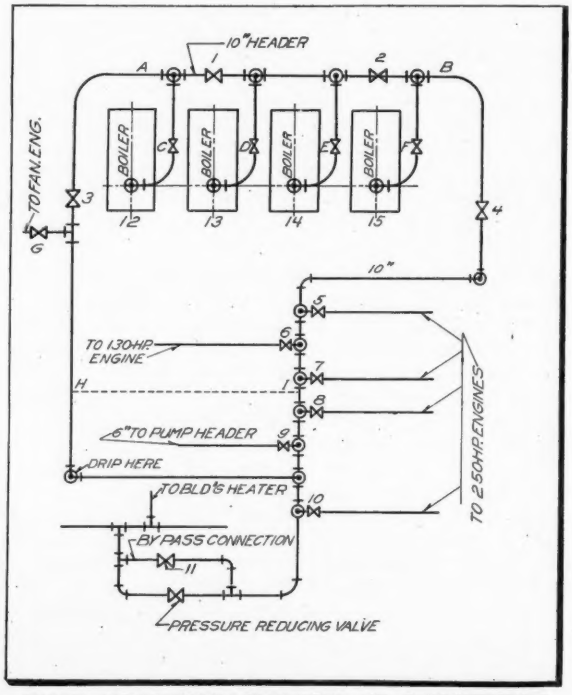
The other specimen was taken from a factory boiler in Evansville, Ind. There were in all 150 lb. of scale removed from this boiler at one time. The boiler was so scaled that the space between tubes was entirely filled in places and a chisel bar and ball chisel were required to remove the deposit. Apparently the man who had been in charge was in the habit of washing the scale back but failed to remove it.

To show the size of the scale the 1-lb. machinist hammer was put in the picture. A. F. Depper.

Criticism of Valve Location

IN the several issues of Practical Engineer of the last 2 months, we find various ways of placing the valves on the drawing submitted by Mr. Hawkins. In the Nov. 1 issue is a sketch by W. P. Flint, showing what he considers a perfect arrangement of the valves. I have drawn a rough copy of the boiler plan and the pipe lines. This I have marked as has Mr. Flint, and then, by letters, have designated the places where I would have placed my valves, were I putting piping system of this kind in commission.

In the article by Mr. Flint 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 are the valves as located by him, while 12, 13, 14 and 15 are the boilers. Now, supposing one wanted to wash out boiler No. 13 or No. 14, how would he manage to keep out the steam from it unless both 13 and 14 were killed? I take it that Mr. Hawkins means for the



VALVE ARRANGEMENT CRITICIZED AND IMPROVEMENTS SUGGESTED

space from A to B is properly a header. If so, I would place my valves at C, D, E and F. And if the management would stand for it, I'd have 2 valves about 1 ft. apart on each end of the feeders from the boilers in place of one valve—this for the safety of the man who was on the inside of the boiler while it was being cleaned.

I see no necessity of the valves Mr. Flint numbered 1, 2, 3 and 4. I should, however, place a valve at G, on the fan line, as well as on the other engine lines. Going farther back, and criticizing the original design, I would not run my line any farther than to the fan engine feeder line, unless, perchance, the line to main engine was too small, in which case I would have made my bend at B and followed the dotted line to A. It would have been much better to have put in a quite different system of piping originally, but since this arrangement was submitted, I presume that the editor does not care for our views as to how we should have done it.

John Pierce.

Successful Kinks From The Plant

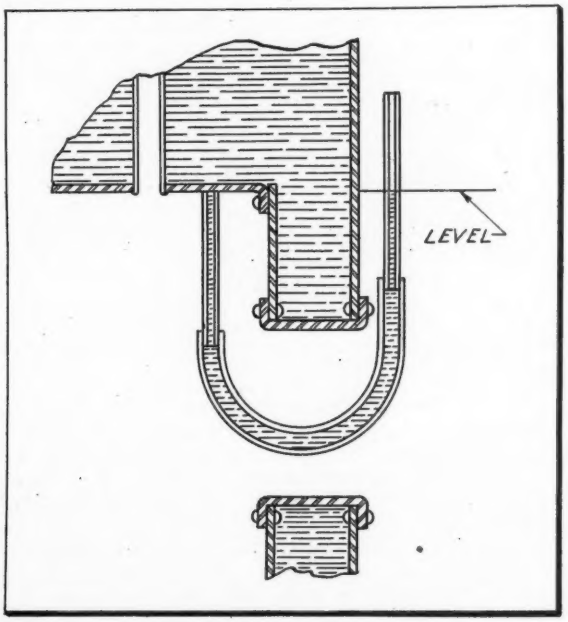
For Saving Time, Work and Trouble

Finding Crown Sheet Level of a Boiler

IT is sometimes necessary to mark very accurately the exact location of the top of the bottom flue or crown sheet on the outside shell of the boiler. This location must be known when changing the position of water glasses or gage cocks.

The top of the sheet can be found of course by the use of rules and other measuring devices, but an error is very easily made in measurements that sometimes lead to disastrous results.

An easy and accurate way to locate the top of the sheet is by means of 2 water glasses and a piece of hose or rubber tubing that will tightly fit an end of each glass.



USE OF WATER LEVEL

Fill the glasses and hose with water until the water levels about an inch from the top of each glass. Hold the top of one glass to the flue or crown sheet as the case may be, tipping it very slightly to allow the escape of air when the other glass is raised. Have the other glass held close to the outer shell of the boiler and raised very slowly. When the water reaches the top of the glass held to the flue sheet, mark on the outer shell of the boiler the level of the water in the glass held close to it. Water seeks its level and this mark will show exactly the height of the bottom of the flue or crown sheet. From this mark the water level is found when the thickness of the flue or crown sheet is added.

Cutting a Key Seat

I NOTE J. E. R. wants someone to give him a simple method of cutting a key way in a valve stem. If he does not care to take the stem to the shop and wants to do the job at the plant, the following is a simple method, as well as practical: Find where you want the key seat cut, then put one center punch mark at that point, disconnect the rigging or all parts from the valve stem bracket, take off the bracket, slip the stem out, place your key seat rule with one side central of the punch mark, scribe a line on the stem as long as you wish the key seat to be, but if longer it does no harm. This line will be the center of the key seat. Now set your dividers to one-half the width of the key seat and scribe a mark at each end and each side, then place your rule on each mark and scribe a line the same as the first line; this will give you 3 lines. Now grind your chisel, which should be a good side or cape chisel, about 1/32 in. smaller than you wish to cut the key way; follow the center line. Make your first cut light so as not to break the sides away. As to the end, you can place your chisel on the mark and cut down a little way, then take another cut lengthwise. If you have your chisel made, as I have described, 1/32 in. small, this will give you 1/64 in. on each side to clean up with a square file. I have used on rough jobs ½-in. chisel for ½-in. key seat, but it is best to allow 1/32 or 3/64 if you are not good with the chisel. It is better to have some to file off of the sides, as when you are filing out the bottom you will naturally take away some of the side. But remember, don't finish the sides until you have the bottom finished.

Now, going back to the start, I would make those 2 lines about 1/64 wider on each side than I wished the key seat to be, then you won't cut the lines away, but cut just inside of them and this will help to keep your key way straight, as you can see where you are cutting all the time.

Remember, this key way must be straight, and if you haven't got the key seat rule, take a combination square or any other square that you have, place it on the end that fits in the T slot of the valve; this is a good surface to square from, as it has been forced off. If you can't make the square come to the punch mark that you have made, just scribe a line the full length of the stem, then take your dividers and step from the line to the punch mark, then measure back to the length of the key seat and place your dividers on the line you made and scribe another line; this will give you the points to work from, then proceed as before.

I might do this job somewhat differently, but what I have described is a good method and by applying some horse-sense it can be cut very nicely, or most any other key way, as I have cut many of them this way in shafting, pulleys, and pinions. J. T. V.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Examination Questions and Answers

I SHOULD like help with a few questions from an examination for second class engineer. 1. What if I were to have a new boiler built and the boiler manufacturer had boiler plate with good tensile strength and good elongation but low ductility? 2. Could I use a plain slide valve and make it a balanced valve? 3. If a solid piston was worn out at the bottom, how would I remedy it and use the same piston? 4. What would I do if I were running an engine with a surface condenser and the air pump should stop? 5. What is the proper object of a vacuum breaker? J. G.

1. No reputable boiler manufacturer would attempt to build a boiler and use sheets in which the ductility was low, no matter what the tensile strength or elongation might be. A standard reference work defines ductility as, "The property of matter by virtue of which some bodies may be drawn into wire."

Ductility is the grain or fibre of metal and as the ductility decreases the brittleness increases. We take a sample of firebox steel and test it and find that it has a tensile strength of, say, 60,000 lb., an elastic limit of 30,000 lb. and is very ductile, so much so that it can be drawn cold to a considerable distance, and hot almost without limit.

Good boiler steel may be compared to a section of long-fiber manila rope, as the fiber is the strength of it for the purpose for which it was made.

Cast iron ordinarily may have a tensile strength ranging from 12,000 to 20,000 lb., and even in some cases to as high as 30,000 lb.; but in any case, the ductility is almost negligible, and on this account, it ought not to be used in the construction of a boiler in any way where it is subjected to steam pressure, as owing to its brittleness and lack of ductility, and also to the fact that it fractures easily with changes in temperature, it is not reliable.

2. Many manufacturers of high-speed automatic shaft-governed engines use the principle of the plain slide valve to handle the steam in the cylinder and provide a suitable device to balance it and thus reduce the strain on the governor mechanism and valve gear.

In the early days, when steam pressures were low and then throttled, the pressure on the back of a plain unbalanced slide valve was not so great but that it entailed no great strain on the eccentric and valve gear. Sometimes it has been found necessary to operate these engines under modern conditions, and it was found that the friction set up in the eccentric was so great that some means must be found to relieve it.

In cases like this, new valves have been designed for the engines, with a suitable device to relieve the valve from the unbalanced pressure. However, it is not always possible to do this on account of lack of space in the steam chest, and an original design which will not permit of any changes whatever without excessive expense.

3. If a solid piston has been in use so long that it is worn off on the bottom, it can usually be turned half way round in the cylinder, so as to bring the worn part on the top. If the snap rings are in good condition, the piston will give good service after the change.

Another way to remedy a defect like this, is to place the piston in the lathe and turn dovetailed grooves in it provided there is room for them, and fill them up with some anti-friction metal, such as babbitt metal or red metal, and aftewards turning this metal down to fit the bore of the cylinder.

4. An engine used for the generation of power for manufacturing purposes, and which is operated in connection with a condenser, should be provided with some automatic device by means of which the exhaust steam will pass directly to the atmosphere should the condensing apparatus become inoperative. There should also be provided, a vacuum breaker located conveniently and which can be opened rapidly.

In case the air pump and condenser fail, the engine can be operated non-condensing and carry at least part of the load. In any event, should this failure occur, open the vacuum breaker at once and let the engine run and exhaust to the atmosphere. Of course, all conditions are not alike; what would be the proper procedure in one plant, might not be considered the best practice in another plant. An engineer must study his plant and become thoroughly familiar with all the details and be prepared for almost any emergency that might arise.

5. A vacuum breaker is some form of a quick opening valve placed in the exhaust line between the last cylinder and the condenser, for the purpose of destroying the vacuum when necessary. Compound pumping engines are usually provided with a vacuum breaker and especially high duty triple expansion engines with either a direct connected or independent condenser. In these engines, the pressure in the second receiver, and consequently the initial pressure in the low pressure cylinder, ranges all the way from 5 lb. above, to 5 or 6 lb. below atmosphere, depending on design and operating conditions.

Consequently, when the airpump is started preparatory to placing the pump in service, the vacuum acting upon the area of the large low-pressure cylinder is sufficient to operate the unit slowly. In fact, in this type of unit, with an independent airpump and condenser, the pump would continue to operate slowly indefinitely after closing the throttle, unless the vacuum breaker were opened or the air pump stopped.

High duty 2 or 3-cylinder compound pumps which have the air pump directly connected to the plunger or some other moving part, will run a number of revolutions after the throttle is closed, and they are provided with a vacuum breaker which is opened as pumps stops under load. G. H. Wallace.

Horsepower of Hoisting Engine; Setting of Locomotive Boiler

WILL you please tell me how to find the horsepower of a hoisting engine the cylinders of which are 10 in. in diameter with a 12-in. stroke; boiler pressure 95 lb. I also would like to know the proper pitch to set a wet-bottom locomotive-type boiler. W. F.

In order to find the horsepower of an engine, 4 things are necessary to know,—the area of the piston, the length of the stroke in feet, the number of revolutions, and the mean effective pressure.

In your inquiry, no mention is made of the speed at which the engine is running, or the mean effective pressure, therefore all we can do is to tell you how to proceed after you have supplied the missing data.

In computing the horsepower of engines used for industrial and manufacturing purposes which operate at a constant speed, it is customary to first find the "constant," which is found by multiplying together the piston area in square inches, and the piston speed in feet per minute and divide by 33,000, which gives the horsepower for one pound m.e.p. When m.e.p. is found by means of an indicator card or another method which will be described, all that it is then necessary to do is to multiply the m.e.p. by the constant, and the answer will be the horsepower.

As the speed of hoisting engines varies to a considerable extent, the constant will vary somewhat from that as described above, other things being equal. The way to proceed now is to divide the area of the piston in square inches by 33,000, which will give a decimal of several figures which will be the constant at 1 lb. m.e.p., and 1 r.p.m. Then, to find the horsepower, multiply this constant by the piston speed in feet per minute and by the m.e.p. as found from the card or by the process as will be shown directly.

Hoisting engines as a general thing are operated with a full valve travel in either direction, unless the haul be long enough so that the engine can be "hooked up" and steam used expansively. This is seldom or never done in small hoisting engines, and the larger and more powerful ones are usually installed where the haul is great enough to pay to hook up.

In full valve travel, the cutoff occurs at about ¾ of the stroke, and this is reduced by hooking up, to about a half, or perhaps 40 per cent cutoff. So in order to arrive at the m.e.p., a table has been arranged whereby the m.e.p. can be found approximately, but in order that it be as close as possible and error reduced as low as possible, the engine should be operating under a full open throttle, as the table is arranged assuming that steam is not wire drawn. The following is the table:

Cutoff in per cent of stroke,	.25	.33	.37	.50	.66	.75
Corresponding constant,	.659	.743	.771	.847	.917	.937

Now, having the table at hand for the more common points of cutoff, use the following rule: Add 14.7 to the gage pressure and multiply by the constant under the point of cutoff that the engine is working under at the time. Subtract 17 from the product and multiply by .9. The result is the m.e.p. for a good noncondensing engine.

The point of cutoff will have to be determined from the engine itself by turning the engine over by hand and after taking the chest cover off, noting that point in the stroke where the valve closes the ports.

Sometimes this work is facilitated by transferring the ports to the frame near the valve stem, and then using a "dummy" valve attached to the stem which will, of course, travel in unison with the valve in the steam chest.

A wet bottom locomotive type boiler ought to be set so that the rear, or firebox end, is about an inch, to an inch and a half lower than the other end, by the level. Of course the boiler ought to be level crosswise. This gives ample water over the crown-sheet at all times if there is enough to cover the tubes at the front end.

With this pitch it is also easier to wash the boiler out from the front end, as the mud will easily flow back into the wet bottom where it will pass out at the handhole which is usually located either in the bottom or in the end below the ashpit door, near the bottom. G. H. Wallace.

Knocking in Engine Cylinder

PLEASE tell me through your columns what the trouble is with my engine. It is a simple high-speed Ideal, 75 hp., running at 300 r.p.m. At the end of the back stroke, or just as it starts ahead, there is a very hard knock in the cylinder; it will stop making the noise on a light load, but as the load comes on the noise increases until it sounds like the piston hitting the cylinder head. The cylinder has been rebored and a new piston and head made and the engine ran satisfactorily for about 6 months when I first noticed a little noise and it has gradually grown worse ever since.

I have gone over every piece of the engine several times but have been unable to find the trouble. Any information you may be able to give me on the subject will be greatly appreciated. D. E. I.

A. When a knock develops in a cylinder, the first step is to see that the piston head is tight on the rod, and that the piston is a reasonably good fit in the cylinder. A simple remedy to try is to screw the piston rod in or out of the crosshead a part of a turn to bring a new arc of the piston circumference in bearing contact with the bottom of the cylinder bore.

There are so many conditions that may cause noise in a cylinder that it is impossible to prescribe any one stock remedy. For example, if the connecting rod box is set up too tight on the crosshead pin or wrist pin, that will frequently cause the piston to knock in the cylinder.

Cases are sometimes found in a new engine where there is a piston knock apparently due to the piston rings being an imperfect fit in the bore of the cylinder, and the noise disappears upon filing the rings until they come to a perfect bearing all the way around. No doubt, noise is sometimes due to taper, or out-of-round bore of the cylinder.

In rare cases, a knock in the cylinder seems to be without any discoverable cause, at any rate the cause is so obscure that it is not discovered. The fits and physical conditions of the parts seem to be without fault and the alinement correct. The piston seems to have an uncontrollable tendency to vibrate or swing across the cylinder bore each revolution to the extent of its play, which in small sizes would be less than 1/64 of an inch, but sufficient to cause considerable noise. A cure has been found in some of these cases, by putting some form of spring in the bottom of the groove in the piston for the rings, thereby providing a yielding support between the piston head and the piston rings for the purpose of steadying the piston. P. E.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Caused the Glass to Break?

WILL some kind reader please explain to me what causes a glass tube, subject to a vacuum, to break after it has been cleaned? Has anyone else noticed this or is it just a combination of circumstances that come under my observation?

The circumstances are these: I noticed the glass in our Leblanc condenser was very dirty and I swabbed it out; the next time I went around I found the glass broken, but as the condenser was not in use at the time, I didn't think much of it, but put in another glass. This one also became dirty in the course of time and was cleaned, with the same result, it broke. So after putting in a new glass I let it go dirty until someone on the other shift cleaned it and it also broke.

Not long ago our mercury column got so badly steamed up for about ½ in. above and below the average height of the mercury that it couldn't be read any longer, so the chief disconnected it and cleaned it, with the result that it broke in 2 places. We did not use a wire to clean them out with, as some say it will cause the glass to break, but I very much doubt this.

When I first started out as fireman, the chief told me never to scratch the label from a new glass with a knife as this would cause it to break when steam was turned into it. Afterwards I saw pretty much the same thing in an engineering magazine. After I got an engine room turn I saw the fireman rubbing the label from a new glass with the back of his knife. I told him it would make the glass break but he said that idea was "foolishness" as they wouldn't break any quicker as long as you didn't scratch the glass, and as he used this method here for about a year without having any unusual amount of breakage, I have about come to the conclusion that he is right.

If rubbing a glass with metal will cause it to break, why don't a glass break after it has had the end cut off with a wheel cutter, as is done every day?

E. C. B.

Question for Readers

IN a rolling mill, in which I once worked, we had an accident which caused a good deal of discussion. The regular night engineer wanted to go home for a short visit and he had made arangements with me to fire for him.

I came onto the job at 6:00 p. m. and everything went alright for about 4 hr., when the piston packing began to blow. It did not blow bad, so I did not touch it. It kept on blowing for about ½ hr. and then stopped suddenly about 10:30. The regular man was coming onto the job at 12:00, but instead, he came about 11:30, so I washed up and went home.

About 15 minutes after I had gone, the stuffing box blew out and they had to shut down. I afterward found out that the day engineer had put in new packing and had filled the box up so that after the gland was put in place, only about ⅛ in. of the bolts was left over.

The regular day engineer says that the nuts worked off, but my theory and the theory of the other engineer is that the packing swelled up, being new packing, gripped the rod and was pulled out. I should like to have the opinion of some of the other engineers on this subject.

I never heard of the nuts on a stuffing box working off, since it has so much pressure against it, but possibly I am wrong. Horace M. Hastings.

Boiler Problem

SHOULD like to have some of the readers answer the following question: Why are the tubes of a B. & W. boiler inclined more than those of the Heine?

R. E. W.

Brush Arc Generators.

I SHOULD like some of the readers to give their experience with Brush arc generators, class 9½ and 4 ampere machines, and how to get best results. I am having my troubles with one and they are something new for me. W. H. M.

Storage Battery Problem

SHOULD like the opinion of engineers of experience regarding a storage battery for electric lighting purposes. We are located in a country town, where there is no electric supply, and have been thinking of installing a plant.

We have a mill in which we use water or steam for power, as the conditions warrant, and have thought that by installing a generator and storage battery of sufficient capacity to operate, as the limit, 40 32 c.p. lamps and charge the battery at the same time, we could use the electric power from the battery at night.

What I wish to know is, which would be the most economical and give the best results, to use the battery as above or take the supply direct from the generator?

J. R. L.

Massachusetts Examinations

EVERY applicant for a license must have served as a helper in a steam plant in Massachusetts or show the inspector a letter from some former employer from some other state, showing that he has worked as a helper in a steam plant for at least one year. He must have knowledge of return tubular, upright, locomotive type, and B. & W. boilers, damper regulators, injectors and inspirators, steam and return traps. Safety valve and water columns are the most important; the valve action of the Dean, Warren and Davidson pumps is also important. Some experience with a heating system is helpful.

If the readers want to know what questions the state inspector ordinarily asks I shall gladly furnish them. I know how hard it is in Massachusetts to get any license, and will be glad to help any fellows to pull through. Julius Maurer.

Turbine Problem

ANSWERING H. P.'s question in Nov. 15 issue: There are a number of things which might cause the turbine to show the results stated. The head race, penstock or tail race may be restricted in area so that at full gate the turbine does not receive the water at the full pressure due to the head.

This, in some cases, will cut down the power developed to a greater extent than the loss of head would indicate, as will be noted farther on. The turbine may be operated at a higher speed than that at which it will show its calculated efficiency. As H. P. does not give the size of the wheel nor the speed at which it is operated, that phase of the question cannot be discussed in its application to his case.

Poor vacuum may be due to slight air leaks and in some cases with a long draft tube the writer has experienced difficulty in keeping the draft tube full of water when no leaks could be discovered and has suspected that perhaps the water in the draft elbow and tube received a whirling motion, possibly due to improper angle of discharge from buckets of turbine, that resulted in a partial hollow core in the column of water, thus impairing the vacuum.

A good way to detect air leakage is to watch the discharge from the draft tube and if there are air bubbles rising, it will indicate the presence of leakage. H. P. can get an idea of the extent of these by admitting small amounts of air through a cock in the draft elbow and noting resulting air bubbles. The 18-ft. draft tube should be equal to 18-ft. head in amount of power developed if everything is right. There is sometimes a tendency for a turbine builder to overrate the speed of a turbine in order to meet the conditions imposed by some particular machine, and more particularly where electric generators are concerned.

In one instance in the writer's experience, a pair of turbines were installed to operate under 18-ft. head and were direct connected to an alternator. While they would give practically their rated power with full head and full gate, a reduction in either caused a rapid drop in power. By belting the turbine to a part of the factory and reducing the speed about 15 per cent, the amount of power developed under partial gate or reduced head was considerably increased.

In another instance a pair of turbines were installed, rated at 100 hp. with 20 ft. head, and after being in operation for a time a watt hour meter was connected into the generator leads so as to record the power generated by this unit and it was discovered that the turbine was developing only an average of 15 kw.

That this was not sooner discovered was probably due to the fact that the switch board attendant had been in the habit of over exciting the field of this machine, thus causing a heavy cross current with other and larger steam driven units, which gave the ammeters a high reading but on a current of very low power factor.

Investigation showed that the average gate opening for a week was 60 per cent, and that the average head of water was 18 ft. 6 in. Care was then taken to keep the head up to 20 ft., and an average gate opening of about 45 per cent resulted, but with only slight improvement in amount of power developed. A little later the fall rains provided sufficient water to run with full gate opening and with 20 ft. head the average power developed was 60 kw.

This was considered proof that the turbine was operated at a speed so high that with either a small loss in head or with partial gate opening its efficiency fell at a rate entirely out of proportion to the reduction in water power input.

In anothed case, a turbine 24 in. in diameter was installed to run 221 r.p.m. under a 15-ft. head and develop 50 hp., and was belted to a line shaft in conjunction with a 250 hp. engine. This belt drive was somewhat too small for the work and the writer discovered that at certain times there was excessive belt slippage while at other times, with the same gate opening the belt would apparently be idle.

Careful investigation at first showed nothing wrong. The speed was correct, there were no leaks and nothing amiss in the turbine, and the situation began to assume an air of mystery. One day, with less than ⅔ gate opening, it was noticed that the belt was slipping and in a sort of a "I don't care a rap what happens" frame of mind, we opened the gate full to observe the results. Instead of slipping more, the belt almost immediately ceased to slip and in a moment was running idle!

We then started another hunt and this time tore up a piece of flooring so we could see the tail race and then found the water bubbling and boiling at a great rate. Being sure we had no leaks at the wheel we went out in the yard and tore up the planking over the end of the head race and exposed the intake to the penstock. Here we found our trouble; the top of the penstock was only about 2 ft. below the surface of the water and with a rapid flow into the penstock, a whirlpool was formed which took in great quantities of air and effectually destroyed the vacuum in the draft tube, which was about 7 ft. in length. A baffle was arranged at the head of the penstock which removed the cause of the trouble.

Using such figures as H. P. has given, we find that: 791.5 lb. water per second $= 791.5 \times 60 \times 60 \div 33{,}000 = 86.34$ hp. Rated power of wheel $= 67$ hp. then; $67 \div 86.345 = .775$ or 77.5 per cent = calculated efficiency of wheel and which, for a wheel of such small capacity under a high head, is in my opinion rather high. I should take 75 per cent at the most, or a rating of 64.75 hp. An 11 in. vacuum = 12.5 ft. of water approximately; $18 - 12.5 = 5.5$ ft. apparent loss of head due to poor vacuum.

$67 - 50 = 17$ hp. loss of power from rating.

$5.5 \div 60 = .0916 = 9.16$ per cent loss in head.

$17 \div 67 = .2537 = 25.37$ per cent loss in power.

Any large discrepancy between the percentage of loss of head and of power will be noticed; either there are other losses in head or the turbine is operated so close to the critical speed that the loss in head due to poor vacuum produces a greater proportional loss of power as in the 2 first instances related above.

The writer has used the following rule for determining the proper speed for a turbine, and found to be fairly accurate for high speed type wheels:

$6.6\sqrt{h} = v$, in which h is the head in feet and v the velocity of turbine in feet per second. Applied; it is $6.6\sqrt{60} = 51+$ for the conditions stated.

This may serve to indicate whether or not the speed at which H. P.'s turbine is operated is excessive.

Sabet.

Massachusetts Examinations

IN reply to the reader who wishes to know the requirements for a Massachusetts license, I would state that while it is impossible to say just what questions will be asked, it is not difficult to give a general idea of the scope of the examination. The writer has assisted several men in securing licenses; and has been present at several examinations, and therefore feels that he possesses some of the correct "dope."

An applicant should have had at least 3 months experience around boilers—preferably in stationary work. Experience is insisted upon by the examiners and it would seem that the insistence is entirely proper, yet men frequently complain that they can't get a license without experience and if they try to get experience without a license they will get "pinched," or something to that effect, but this is not so. There are many positions such as coal passer, stoker, etc., where men can get the right sort of experience and earn fair pay at the same time. If a man has had a few months experience in such a position and has kept his eyes and ears open, it is not likely that he will fail in the examination.

Here are a few things that he should have learned. First, there is the apparatus in the plant where he works. In all probability the examiner knows just about what that apparatus is, and it is natural and proper for him to find out how much the applicant has learned in the time he has spent about the place. Learn, then, how the gases circulate about or through the tubes; how the water circulates; where the feed water enters; where the blowoff is located and why; the water column, why is it at a certain height, its care; where the fusible plug is located and why; the feed water regulators, how they work and what to do if they fail; the pump governor; the feed water heaters, whether open or closed, some idea of how they look inside and how they operate, how to by-pass them in case of trouble; the inspirator and how to operate it; the method of handling and cleaning fires; the economizer, its purpose and care needed; how to "cut in" a boiler and how to "cut it out"; what to do in case of low water; in case a fusible plug lets go. These are samples of the things the examiner will expect the applicant to have seen, and learned about.

Of course if there is no economizer, or if there are no feed water regulators, he will not require any knowledge about them. His purpose is to learn how observing the applicant has been, and how much he has learned of the things about him. To be safe in the fire room, a man must be obsrvant; and therefore such questions seem to be a fair test.

Usually the engineer will gladly give permission to enter a spare boiler; and with some one along to explain things, much may be learned in a short trip. The purpose and location of each opening, the kind of braces, how attached, how joints are riveted, condition of tubes and shell, then externally in the firebox and combustion chamber, or in each pass, if it be a water tube boiler, there will be things to notice. Cleaning a boiler is dirty, disagreeable work, but most of us have done it at some time, and it is a fine way to get the required information; so if one is elected to such a job, let him go at it with a will.

It is practically certain that the applicant will be questioned closely about the water column, the most important thing about the boiler. He should know what will happen to the water in the glass if the bottom connection is shut or plugged up, what will happen if the top is shut, or if both are shut. The best way to do is to try each thing 2 or 3 times and see for one's self. Then try it on other columns to see that the results are not the freak of that one. The question may be put in a rather roundabout manner, so it is important that the applicant understand this subject thoroughly. No man can hope to pass unless he does. , He should also know how to leave a plant that is shut down over night without a watchman. In this case, of course, fires are banked and the water level raised to third gage, to make up for leaks and condensation in steam lines, water glass shut off and drained. The reason for draining the glass is this. If water is left in the glass, a man might come in in the morning and, forgetting that the glass was shut off, go to work on the assumption that the level in the glass was true. If drain from glass is open, no one will ever make that mistake. This is a valuable little kink.

Massachusetts laws forbid the installation of automatic valves on water glass connections, and when valves are installed on water column connections require that they be of outside screw and yoke type and locked or sealed open. It would be well for the applicant to get a copy of the book of rules and look it over.

A little knowledge of low pressure heating work with direct returns would not be amiss. The names of various fittings, the types of valves, the purpose of check valves, and some knowledge of pumps and how they work may help.

The second question may safely be answered in the negative. Even of a first class engineer it would not be required that he know details of every boiler made. The applicant will be questioned mainly upon the horizontal return tubular. If he knows something of a Manning or water tube it may help. But he must know the return tubular, the names of the various parts, shell, tubes, braces, tube sheets or heads, dry sheet, uptake, difference between flush front and overhang, why rear head is flanged in and front head is flanged out, and why rivets of the latter require protection, why blowoff pipe needs protection, and possibly what to do if the manhole plate falls in with 60 lb. of steam on,—a few inspectors still cling to the old chestnut.

A closing word of caution. Make the application out carefully and neatly. Don't omit anything, particularly in line of experience, and don't overstate. Send a good impression ahead of you.

William E. Dixon.

Burning Shavings

IN reply to B. O. G., on page 1203 of Dec. 1 Practical Engineer, I will state that his sketch and idea of a Dutch oven are correct. My experiences with these furnaces are that they will burn any kind of wood, such as slabs, edgings, saw-dust and shavings; to my knowledge they have never been operated with coal I shall be glad to give further information if B. O. G. desires.

W. Gleason.

IN Dec. 1 issue of Practical Engineer, B. O. G. asked about the Dutch oven used in the west. He did not state the size of his boiler, so we will take one that is much used on the coast—60 in. by 16 ft. From the bottom of the ash pit to the top of the grates the distance should be from 26 to 28 in; from the top of the grates to the top of the arch should be 32 to 36

in. The top should be made of wedge brick, as it will last longer and is much stronger; let it extend far enough under the boiler to protect the breeching.

Make the furnace square; 5 ft. will be large enough for this size boiler. Put the nozzle or feed hole in the center so that the shavings will fall on the center of the grates. Slope the bridge wall from the grates to the center of the boiler within 14 in. of the shell; the top layer of brick should be laid flat and covered with fire clay, making it smooth as possible. Don't fill up behind this wall except for the blowoff pipe protection.

From B. O. G.'s sketch it would seem that he intended to feed the furnace direct from the cyclone which I think is wrong; this cyclone should set over a stock room, one pipe going to the conveyor, the other to the stock room. The conveyor should run inside the stock room to keep the dust from the boiler room. When the furnace is full, the fan should be stopped and the damper in the stack partly closed, or there would be a very dangerous back draft, which has caused some bad fires here on the coast.

The conveyor is much safer and if there is more than one furnace it would be best to burn all the shavings in one furnace. If crowded for steam, shavings and wood or coal mixed will not do. In the large plants here, the fireman does all his work from the top of the furnaces, controlling the feed with levers and slides connected to the bottom of the conveyor.

If B. O. G. is an old reader of Practical Engineer and will go home and dig down, he will find in his Jan., 1910, number, page 94, a good drawing of a Dutch oven will be found. The dimensions are about right with the exception of the bridge wall, which for shavings I think should be a little longer and flatter. The pipe from the conveyor should be larger at the bottom than at the top to prevent clogging.

Chas. Burns.

"J. C." CAN PROVE HE'S RIGHT

Other Facts of Interest to Subscribers Who Use "Readers Service"

By the Journeyman Engineer

"J. C.," a subscriber at Rainier, Washington, has had trouble with the Electrical Lighting System, in the plant which he operates, and asked Practical Engineer for a remedy. The following letter explains his difficulties:

Ranier, Wash., 12-30-12.

Editors of Practical Engineer.

I would like a little advice concerning my electric lighting system. I just installed a 15-kw. 110-volt compound-wound dynamo. I have one circuit 2500 ft. long from the switchboard as follows: 500 ft. No. 6 W. P. wire, 1000 ft. No. 8 W. P. and 1000 ft. No. 10 W. P. Now, 600 ft. from board is an office branch 100 ft. long with 20 16-c.p. carbon lamps. 500 ft. farther on are 4 16-c.p. lamps; at the end of No. 8 wire is the hotel and rooming house with 30 16-c.p. lamps and at the end of No. 10 wire are 2 residences with 6 or 8 lamps apiece. The temperature here averages 40 to 50 F. above zero, the voltage at switchboard was 118 v. at time of test, 112 at office and 85 at hotel.

The management had an electrician construct the line and it's hard to make the owners believe the wire is too small. Now what is the matter and how can I prove it to them? Can I make any other changes to help it. The machine runs cool and sparkless and as smooth as a watch. The owners seem to think there is something wrong with the installation as I did it myself. Please answer immediately.

Thanking you in advance,

Yours very truly, "J. C."

Many question of similar nature have been satisfactorily answered by Practical Engineer for subscribers. It sometimes needs the approval of a disinterested authority to help employes prove to their employers that their installations are correct and that reasons for failure to deliver results guaranteed by sub-contractors who have put in part of the work, does not rest on the shoulders of the employe.

Below is our letter which will clearly prove to his employers the reason for the unsatisfactory service of the present equipment:

January 8, 1913.

"J. C.,"
Rainier, Wash.

Answering your letter of December 30th, it is quite apparent that the electric contractor who installed your wiring greatly underestimated the size of the wire required.

In the enclosed sketches, No. 1 shows the existing conditions as we interpret them from your letter; and sketch No. 2 shows the wiring as it should be to secure proper results.

In sketch No. 2, you will notice that we have allowed for a drop of 4 volts to the first building; of 6 volts to the hotel, and of 8 volts to the residences, which should give good results.

The total load on your generator is only about ¼ its capacity, and the fact that there is a drop of voltage on your line has no connection whatever with the operation of your generator, as long as it is not overloaded; and the only remedy we can see for your trouble is to install a new line.

Yours very truly,
Practical Engineer.

READER'S SERVICE DEPT.

THIS department receives hundreds of questions to be answered every month and in some instances a question will entail much research and long calculations. This takes time and delay is unavoidable. Every question that comes in is taken up in the order that it is received and as promptly as possible. Frequently there is a congestion of work in the Service Dept., and the questions accumulate repadily.

Questions that are referred to our consulting experts must have time for transmission and return to us and frequently the expert is busy with other work and cannot answer the question at once.

Much unnecessary delay would often be avoided if the questioner would give all the details he can, as frequently necessary facts are lacking and many assumptions must be made.

Bear in mind that every communication must be signed with the full name of the writer and the correct address given, although these are not published. No anonymous communications will be answered.

Answers to problems appearing in the problem department will be accepted at the discretion of the editors. We frequently receive many lengthy replies in answer to the same problem and as it is impossible to publish them all we are compelled to select what seem to be of the greatest benefit to the readers.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Subscription Price, One Dollar a year in advance to any Post Office in the United States or Mexico or United States possessions.
To Canada One Dollar and Seventy-five Cents; to Other Countries Two Dollars and Fifty Cents a year. Single copies 10 cents.
Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill. Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

Copyrighted 1912 by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,500

CONTENTS

Chicago's Newest Central Station. Illustrated....109
New Facts About Our Earth. By Leonard Keene Hirshberg..114
Oil as Emergency Fuel. By Reginald Trautschold. Illustrated....115
Isolated Plant Costs. By Lewis C. Reynolds....118
An Interesting Remembrance....119
In the Early Days....120
Motor Trucks....121
Practical Electrical Engineering. Illustrated....122
Storage Battery Practice. By M. C. Saeger. Illustrated....124
Water Jacket Troubles....124
Large Gas Power Station in Japan. By W. A. Tookey. Illustrated....125
The Gas Turbine. Illustrated....128
Compound or No Compound. By N. Devering....129
The Slide Rule as a Wire Table. By F. E. Miller. Illustrated....131
Practical Refrigerating Engineers' Association Annual Meeting....132
Management of Steam Boilers. By Norman Register....133
Correspondence of an Old Engineer and His Son....134
Foreign Investigation and Development in the Power Plant Field. By J. H. Blakey....135
Letters Direct From the Plant: Slotting the Commutator. Starting a Corliss Engine. What Caused Broken Flywheel? Oil Setting Tanks. Electric Elevators. Check Valve Problem. Device for Removing Hopper Gas. Specimens of Boiler Scale. Criticism of Valve Location. Illustrated....136
Successful Kinks From the Plant: Finding Crown Sheet Level of a Boiler. Cutting a Key Seat....141
Questions and Answers. Examination Questions and Answers. Horsepower of Hoisting Engine; Setting of Locomotive Boiler. Knocking in Engine Cylinder. Illustrated....142
Problems for Discussion—What Caused the Glass to Break? Questions for Readers. Boiler Problem. Brush Arc Generator. Storage Battery Practice. Massachussetts Examinations. Turbine Problem. Burning Shavings....144
Readers' Service Dept.: J. C. Can Prove He's Right....147
Editorial: Sleuthing for Copper....148
A Fatal Mistake....149
News Notes....149
Nordberg Belted Type Air Compressors. Illustrated....150
New Plant of H. W. Johns-Manville Co....151
Otis Water Purifying System. Illustrated....152
New Starrett Hub Micrometer, The. Illustrated....152
Office Building Smokestack. Illustrated....152
Coppus Turbo Blower. Illustrated....153
Book Reviews....154
Catalog Notes....154
Trade Notes....155
Practical Reference Tables: Wire Tables. Tables of Cylinders for Compound Engines. Heating Surface of Tubes in Square Feet. Steam Space in Horizontal Tubular Boilers. Dimensions of Return Tubular Boilers and ½ Arch Boiler Settings for Bituminous Coal.... 95

SLEUTHING FOR COPPERS

In these days of big things it is easy to overlook the small ones which make big ones possible. The largest successes are based on careful attention to small economies; the suggested issue of half cent coins, while it may seem paltry is a recognition of this vital fact.

Small savings make big profits,—with a percentage of the saving rightly due to the man who makes the saving possible. Economy in the engine room is, as has been preached much and practiced somewhat, a part of the engineer's job. And records to prove that he has done it are essential to his own satisfaction and the recognition by the "old man." But there is a bigger field in which the engineer has a better opportunity to initiate savings than almost anybody else in the plant, because he is usually, here, there and everywhere about the factory or plant.

The much discussed "efficiency engineer" is simply a man who goes about keeping his eyes open for little and big wastes of time, effort, material and power. There is hardly a place in the world where work is done that some saving might not be made in one of these items by changing methods, moss grown methods that exist because of tradition and habit, but have no real reason behind them.

The essential points are, is time that should be productive being spent in waiting for work or tools or in just "visiting"? Is arrangement of tools such that there is waste of energy in carrying things back and forth, in putting down and picking up, in changing for different jobs, in doing things in the wrong order? Is more work spoiled than should be, from poor material, poor tools or carelessness, or are pieces so made that stock is wasted in the finishing? Last, but nearest to the engineer's domain, are machines running idle? Are transmissions in bad shape? Are motors running for long periods greatly underloaded?

Well, what does an engineer know about these? He may not be an expert in all these matters, but he can have a watchful open eye and an alert mind; and, it is often the casual observer who sees faults which escape the man who passes them every day and "doesn't notice." Besides, practice brings power; and the engineer who can and does suggest improvements here and there outside his immediate department is quite certain to find his field of responsibility growing with proportionate increase in returns to the firm and himself.

As to the fear of "butting in," it isn't necessary. Suggestions are always welcome if made to the right man in the right friendly spirit, and it is a reasonably safe bet that the "old man" will find before many moons where the ideas come from.

The engineer has the chance; if he is wide-awake enough to grasp it, he will have the common sense to determine whether his ideas are practical and possible; and he can make a chance to grow where there may seem little opportunity in the power plant proper. But always remembering in the sleuthing, to keep a sharp eye on the ordering of his own special house.

A FATAL MISTAKE

Cold Water Turned Into a Hot Boiler and 9 Men Killed

ON Dec. 28, a stationary boiler in the shops of the Seaboard Air Line Railroad at Hamlet, N. C., exploded killing 9 of the employes. The explosion was caused by turning water into the boiler while it was hot. The dead are: C. B. Utter, general foreman; W. T. Utter, assistant foreman; H. G. Reynolds, electrician, all white. Charley Ledbetter, Jim Powers, Will Barrentine, John Thompson, Ed Gilchrist and John Marison, colored. All of the principal lines of this railroad pass through Hamlet and the principal shops are located here, with a large number of men employed so that it is remarkable that the dead list is not larger.

At 7 o'clock when C. B. Utter reached the roundhouse, it was reported that the boiler was out of order He and Will Utter were inspecting it when the explosion occurred and the building was demolished.

So great was the force that one of the boilers was hurled through a brick wall 18 in. thick and thrown over 500 ft.

INDEX FOR 1912

THE index for Vol. XVI of Practical Engineer is now ready and will be mailed to subscribers upon request.

NEWS NOTES

THE EPPING-CARPENTER CO., manufacturers of pumping machinery of Pittsburgh, Pa., announce that it has opened a branch office in Chicago, Ill., at 728 Monadnock Building. This office will be in charge of R. E. Burke, formerly of the International Steam Pump Co.

THE CHAMBER OF COMMERCE, by a unanimous vote, recently decided to approve the application of a grant of land near Cohoes, N. Y., for the Cohoes Co., on which to build a power plant.

ON JAN. 1, the official title of the Dearborn Drug and Chemical Works was changed to the Dearborn Chemical Company. There is no change in officers, offices or the effective methods of carrying on the company's work.

CONCRETE is being made at the plant of the Alabama Power Plant Co., in East Gadsden, Ala. The foundation for the building is 50 by 100 ft. The building will be started this winter.

A NEW POWER HOUSE, more than doubling the capacity of the present plant in Coshocton, Ohio, will be built by the Coshocton Light & Heating Co., the coming summer. The big improvement will cost from $60,000 to $75,000 according to the estimate of Superintendent C. H. Howell.

A LIGHT MANUFACTURING building costing about $70,000 will be erected by Jacob Wellauer on the south side of Chicago street, Milwaukee, between Broadway and Milwaukee street. Plans for the building are being drawn by Messmer & Bros. According to Mr. Wellauer, construction will begin in the spring, and the building will be ready by Oct. 1. The building will be 6 stories in height and 60 by 120 ft. in dimensions.

ANNOUNCEMENT HAS BEEN MADE that capital stock of $1,000,000 has been subscribed to establish an electric power plant in Pineville, Ky. Contracts have been made for the purchase of the local plant and that at Middlesboro and all similar equipment at the various coal mines. The new organization will furnish power for Middlesboro, Pineville and the mines. It will also furnish power to an independent company for a trolley line between various points in Bell county.

AT ALLIANCE, OHIO, the city council has passed an ordinance for a $15,000 municipal light plant which will be constructed at the water plant.

WORK ON THE NEW FACTORY for the Risdon Tool & Machine Co., of Naugatuck, Conn., is being pushed as rapidly as possible.

CENTURY KNITTING CO., of Spring City, Pa., is building a 2-story brick factory, 72 by 140 ft. in size, at Pottstown. The concern will employ 150 people.

AT ALAMEDA, CAL. contracts have been signed with the electricity commission for the construction of a group of buildings to house the municipal light plant. Besides the main powerhouse there are to be 2 other structures erected to house auxiliary parts of the big plant. The buildings are to be completed within 20 working days. They are to be of fireproof material and of mission design. The lines are now being run for the different structures. In the auxiliary buildings will be the office of the superintendent of the plant, the fire alarm batteries and storage quarters for surplus material. It is planned to have machinery ready for operation with the completion of the buildings.

CONSIDERABLE STIR has been created in business circles by the announcement of something of the general plans of the Erie Railroad for future improvements in Meadville, Pa., and along the line. It has been stated that President Underwood approved the plans for the proposed new power plant to be erected in connection with the Meadville shops of the Erie. To that statement may now be added the fact that not only have the plans been approved, but it is very likely that the plant will be started early next spring and pushed to early completion, which means that it will be finished during the summer.

This is especially good news, for it means much more than might appear to some on the face of the bare statement that the Erie was about to build a quarter-of-a-million power plant in Meadville. There is little doubt in the minds of some of the local officials that it means the rebuilding of the Meadville shops on a materially larger scale.

With the installation of the electric plant there will be the necessary installation of equipment for its use in all the buildings, the intention being to drive all the powerful machinery of the Meadville shops with electricity.

COVERS WERE LAID for 56 persons at the Fourth Annual Banquet of the West Penn Electric Co., held in the New Zimmerman House, Greensburg, Pa., Dec. 11, 1912.

The regular monthly meeting was held in the hotel parlors at 11 a.m., previous to the banquet. Superintendent of Lighting, W. R. Kenney, presided over the first period, later turning the meeting over to District Superintendent Wm. Snite at which time papers were read by E. I. Barnard, on "Electric Motors vs. Gas Engines," and L. T. Jackman, on "Meter Reading and District Work."

The dining room decorations bore out the Holiday spirit, while roast turkey and the necessary accessories occupied a prominent place on the menu. A concealed orchestra furnished excellent music for the banqueters.

With Mr. W. R. Kenney as toastmaster, responses were made by quite a few of those present, among whom were E. D. Dreyfus, statistician; H. P. Chambers, superintendent of lighting; T. S. Henderson, manager of the New Business Department, all of the Pittsburgh office; F. A. Moesta, district superintendent at Kittanning, and W. S. Anderson, chief clerk of the Connellsville office.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

NORDBERG BELTED TYPE AIR COMPRESSORS

A Compact, Self-contained, Small Unit with Efficient Unloading Device and Intercooler

WHILE it is well recognized that Corliss compressors are best adapted to the larger capacities, from 100 cu. ft. per minute upward, and they maintain their high efficiency in sizes smaller than this, the cost per unit of capacity rises to such an extent as to make them commercially unattractive, except where fuel is expensive. There is, therefore, a large demand for power driven compressors in sizes from 200 cu. ft. per minute up to 1200 cu. ft. per minute. The Nordberg "S.C." compressor has been designed to fill this demand.

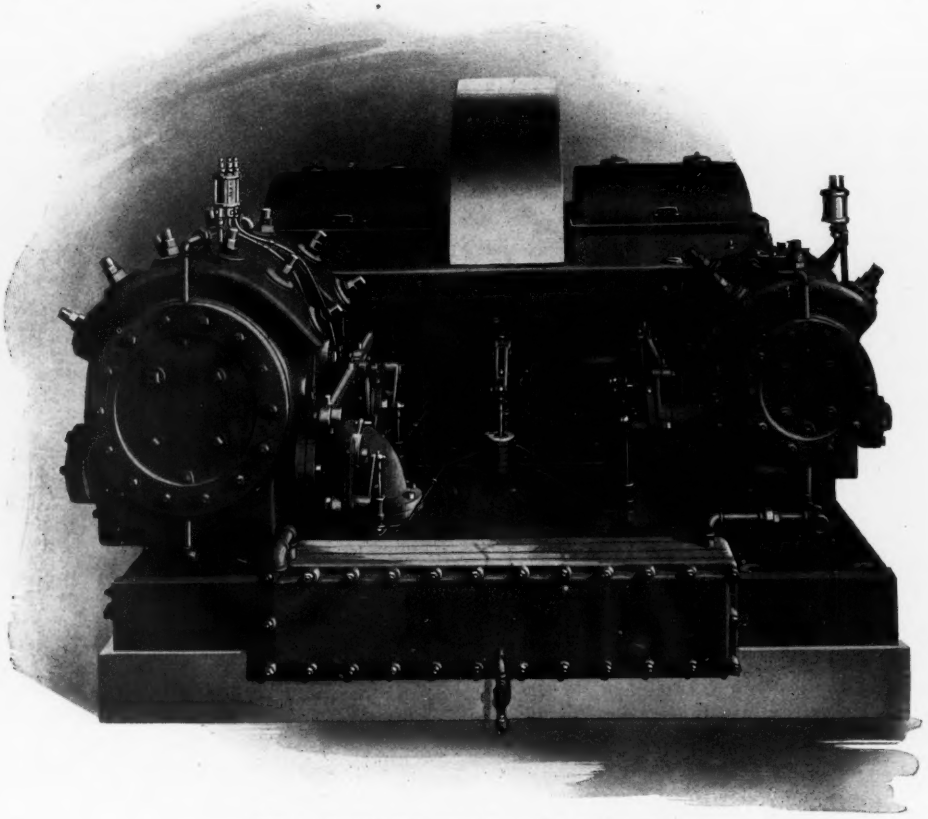


FIG. 1. NORDBERG TYPE S. C. AIR COMPRESSOR

Rigidity and compactness is obtained by the use of a frame, which is one casting, containing the main bearings and slides with an extension which serves as a base plate for the air cylinders and also as space for intercooler. The cavities under the cranks serve as oil reservoirs; the slides are bored and the cylinder flanges faced at one setting, hence the entire machine is self-alined and self-contained.

The cylinders are thoroughly water jacketed, not only on the barrels, but on the heads. The separation of head and barrel jackets does not depend upon a gasket, but is made with an outside connection. The cylinder and valve bonnets are counterbored.

The outlet valves are of Nordberg self-acting poppet type, each size of compressor being supplied with sufficient number to give ample area with low lift.

These valves are located in cages and are provided with removable seats. By removing valve cap, the entire valve, cage, spring and seat are easily removed. The construction of the valve is shown in Fig. 2.

The general requirements of an air compressor of this type demand that it be run at constant speed, maintain a constant pressure and deliver a variable quantity of air, depending upon the demand for air. Each of the inlet valve arms is provided with a latch which carries a lever actuated by a small air piston. The end of this lever is central with the valve stem, hence receives no motion from movement of valve arm.

When the latch engages the hook, which is keyed to the valve arm, the inlet valve is opened and closed by eccentrics, but when the latch is disengaged the valve remains stationary and open, hence no air is compressed.

The governor consists of a cylinder provided with a piston loaded by weights and springs, and counterbalanced by the air pressure; and it is further provided with an oil pot to insure smooth operation.

Tapped off the pressure cylinder at successively higher points are ports which admit air to small pipes which lead to the small pistons opening the valve latches. As the air pressure rises, the ports are successively uncovered by the piston, thus admitting air under the small pistons which operate the latches.

In a 2-stage machine, the crank end of the low-pressure cylinder and head end of the high-pressure cylinder are first unloaded simultaneously, then the other 2 ends follow if the demand for air continues to decrease. In a duplex machine, the unloading is done in 4 steps.

The entire economy of 2-stage compression over single stage depends upon the cooling done by the intercooler. In the Nordberg type, this is located in the base and is one of the most important elements in the design of the compressor. The cooler is made up of 1½-in. tubes, closed at one end, around which tubes the air is made to pass several times by means of baffles. Inside these large tubes are smaller tubes open at the ends and extending nearly to the end of the large tubes. The water circulates in through the small tubes and returns through the space between the small and large tubes. The small tube plate is provided with a cover carrying baffles for the water, so that the entire cooler is built strictly on the counter-current principle, the advantages of which are well known to all engineers.

These compressors are among the latest designs of the Nordberg Mfg. Co., of Milwaukee, Wis., and represent the application of the most modern theories of air compression in small quantities.

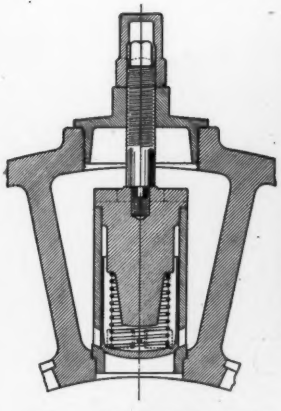


FIG. 2. NORDBERG POPPET TYPE OUTLET VALVE

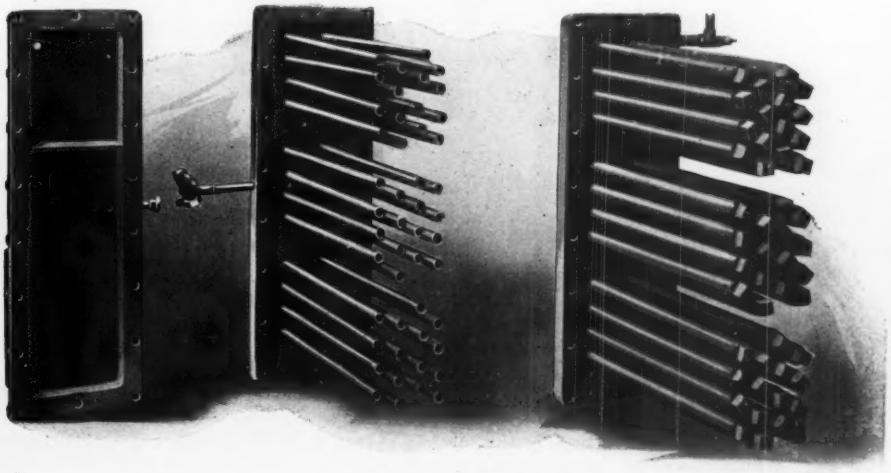


FIG. 3. PARTS OF INTERCOOLER

THE MAN who does not read is very likely to be a little conceited and think that he knows just how to do things without help from any outside source.

He is inclined to think disparagingly of a "book" engineer, as he sees fit to call the man who reads and tries to keep posted and up with the times. He is generally the first to condemn any new appliance that comes out.

NEW PLANT OF H. W. JOHNS-MANVILLE CO.

IN the new plant of the H. W. Johns-Manville Company, at Manville, N. J., are included 9 buildings, which, together with their products, are classified as follows: a—Textile and Packing; b—Rubber plant; Electrical Specialties and Printing Department; c—Pipe Coverings; d—Paper Mill; e—Magnesia; f—Roofing; g—Mastic and Waterproofing; h—Roofing Coatings; Power Plant and Pump House.

These building are of brick, steel and concrete, planned for safety and operating conditions for the employes. The "daylight" form of construction which is employed throughout permits a flood of light to enter the buildings through large triple-unit windows placed close together. Healthful ventilation is furnished by means of steel ventilating sash which provides a constant supply of fresh air without causing drafts.

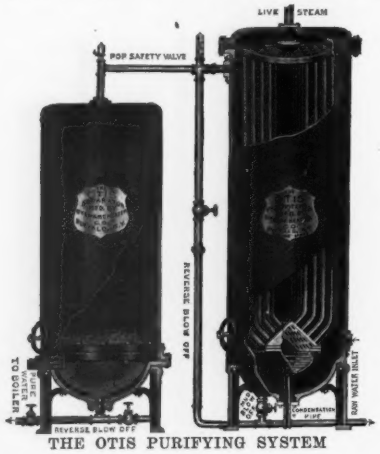
Each building has an average length of 1000 ft. and is a separate factory in itself capable of being operated as an independent unit without relation to the other buildings in the group. The total combined floor area of all the buildings is about 1,000,000 sq. ft.

Power is furnished by the company's power plant, which consists of the latest type of General Electric turbo generators, 6 Babcock & Wilcox high-pressure water-tube boilers aggregating 5000 hp. All steam pipes are insulated with J-M Asbesto-Sponge Felted Covering in order to effect a maximum saving of fuel. Power and lighting cables, instead of being strung on overhead poles, as is generally the case in factory installations, are led underground through conduit, thereby eliminating cable troubles. The buildings are heated by exhaust steam also conveyed underground from the power plant.

The new plant is located on a picturesque tract of 320 acres, divided by the Raritan River, in the town formerly known as Findern, N. J., but which name was changed to Manville. The company's private railroad system, comprising 5 miles of tracks, connects directly with the Central Railroad of New Jersey, the Lehigh Valley and the Philadelphia & Reading Railroad, and these railroads have made preparations to operate special work trains to and from Manville for the accommodation of those of the 3000 employes who live in nearby towns.

OTIS WATER PURIFYING SYSTEM

IN the Otis System for purifying feed water for steam boiler use, is a precipitator and a separator. The feed water should first be heated by exhaust steam in a feed-water heater of some good make, preferably a pressure heater that will bring the temperature of the feed water up to 200 deg. F. Then instead of allowing this water to go into the steam boiler let it pass first through the precipitator where a small amount of live steam is introduced into the tubes of



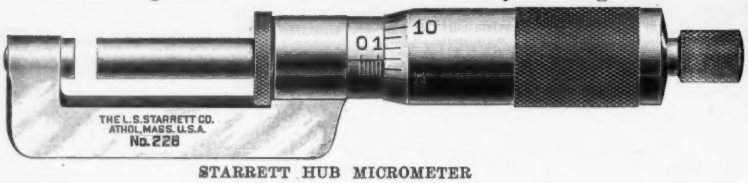
THE OTIS PURIFYING SYSTEM

the precipitator to bring the temperature of the feed water up to 300 deg. or over before is passes into the separator.

This separator is constructed with 3 grades of the best emery, also cast-iron perforated plates and several copper screens to hold the sediment after it is separated from the water. The feed water then passes through this bed of emery which is made of thickness and surface to hold all of the impurities from going into the boiler. For this reason the system is guaranteed by the makers, The Stewart Heater Co. of Buffalo, N. Y., to prevent the formation of scale of any kind on the tubes or plates of a steam boiler, and is shipped by them on this guarantee to all responsible users.

THE NEW STARRETT HUB MICROMETER

A NEW style of micrometer made by the L. S. Starrett Co., of Athol, Mass., is particularly adapted for measuring thickness of hubs in wheels and gears where extreme accuracy is of importance. Until recently the only method of measuring hub thicknesses has been to lay a straight



STARRETT HUB MICROMETER

edge on one side of the hub and put a steel rule through the bore, reading the thickness on the opposite side from the straight edge. Sometimes when the total diameter of the wheel or gear was small a pair of calipers was slipped over and the thickness of the hub calipered in the usual manner.

This new Starrett micrometer does away with liability of error common with the rule or caliper method because the measurement is made direct and the micrometer reading insures accuracy.

The feature of this micrometer is the frame, which instead of flaring out in a semi-circular form is offset only slightly from the center line of the spindle. By making the frame narrow, it may be easily inserted in holes as small as ¾ in. in diameter.

The micrometer has the Starrett speeded thumb piece and ratchet stop, and also lock nut for use when the micrometer is to be used as a gage.

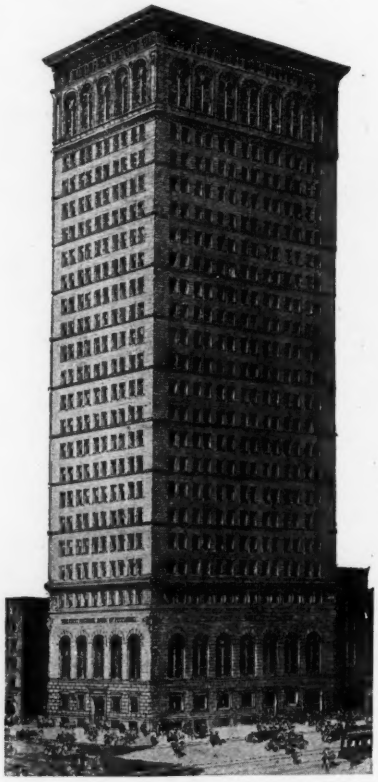
OFFICE BUILDING SMOKESTACK

How a Pittsburgh Building Solved the Problem Easily

THIS building is located on one of the Smoky City's best business corners, is 26 stories in height, and of the latest and most improved type of modern fireproof construction throughout.

The smoke stack, rising 400 ft. in the air is lined throughout with 2-in. J-M Vitribestos manufactured by the H. W. Johns-Manville Co., and applied by its Pittsburgh branch.

The Vitribestos lining is attached to the interior of the stack to a thickness of only 2 in., consequently does not occupy much flue space, but presents a solid


FIRST NATIONAL BANK BUILDING AT PITTSBURGH, PA.

interior surface, thus protecting the metal stacks from sulphurous and other destructive acids and insulating them from great heat.

Large slabs, 3 by 6 ft., of 2-in. thickness, weigh, with all attachments, only 30 lb. per cu. ft. in place, or around 5 lb. per sq. ft. of stack area. Weight

must be considered in determining the strength of foundation and in its general strain upon the entire building, all of which is one riveted unit. The weight of the lining must finally be supported by the stack, whether the latter be of steel or brick construction.

It is evident that this lining, weighing so little, must result in saving, by allowing reduction in diameter and thickness, which will go far to pay the difference in its first cost.

A 5-in. lining in a 6-ft. diameter stack obstructs 26 per cent of the opening, but a 2-in. lining obstructs not quite 11 per cent. While this building was designed to be 26 stories in height, only 5 stories were built in the original undertaking completed 4 yr. ago. This part of the building is nearly all occupied by the bank, which continued to occupy it while the remaining 21 stories were being erected. Four years ago the stack erected for the 5-story building was lined with J-M Vitribestos, and it then became necescary to build this stack to a total height of 400 ft., without interfering with its use, as the bank required operation of the furnaces for heating purposes during the winter.

The extension of the stack was made by manufacturing the steel in 18-ft. sections and riveting all joints except at the ends of the sections which were flanged joints. The 18-ft. sections were lined with Vitribestos before they were carried to the building, and these sections were hoisted and set in place without interfering with the operation of the stack. When the last section was set in place, the stack was perfectly lined with the exception of the open joints every 18 ft.

With the arrival of mild spring weather, these joints were sealed up and inspection showed that the material which had been in service for 4 yr. was in as good condition as when first applied.

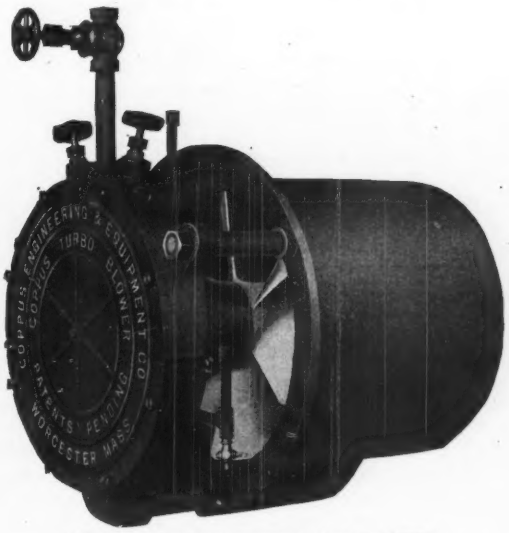
COPPUS TURBO BLOWER

THIS device, recently introduced for accelerating draft for boiler fires, consists of a steam turbine driving a fan blower, both turbine wheel and fan wheel being mounted on the same shaft. The outfit is placed in the ash pit wall with the turbine entirely outside, while the fan wheel revolves in a cast-iron cylinder projecting into the wall so that the air will be delivered into the ash pit. The entering air passes around the turbine and through the fan wheel.

This blower has the advantages of simplicity and those of forced or undergrate draft. It is customary to install a Coppus blower for each boiler unless the boilers are very small, in which case, one blower furnishes air for 2 boilers, the damper arrangement being such that the draft to either boiler may be cut out while the boiler is shut down for cleaning or repairs. On very large boilers excellent results are obtained by dividing the ash pit by a wall into 2 parts, so that one portion of the grates may be cleaned and the load carried by operating the rest of grate at a maximum load. Only a small portion of the furnace is thus cut out and the boiler develops nearly its rated capacity.

The turbine of the Coppus is of the impulse type, the wheel being a flat disk, having on its periphery a large number of smooth drawn steel buckets, over 200 on most sizes. The number of buckets is sufficiently large and the buckets near enough together to insure efficiency. The bucket wheel is made to revolve by the steam, which is admitted under pressure to a steam chamber within the turbine casing. From this steam chamber, which is of minimum dimensions in order to reduce radiation losses, the steam passes through 3 nozzles, one of which is connected direct to the steam supply pipe while the steam to the other 2 may be shut off by hand-operated valves on each side of the steam pipe. The nozzles deliver jets of steam against the buckets at an angle of 20 deg. to the plane of rotation. The placing of the Coppus buckets and the angle at which the steam reaches the bucket wheel is in accordance with the practice followed by the manufacturers of the best turbines of the impulse type.

After doing its work on the buckets of the revolving wheel, the exhaust steam leaves at the bottom, passing through an elbow formed at the lower side of the casing and then through a pipe extending beneath the fan blower and forming part of the lower side of the casing. Discharging in an upward direction, the exhaust steam mingles with the current of air raising its temperature before it enters the ash pit.



COPPUS TURBINE WHEEL AND BLOWER

The shaft which carries the turbine wheel and fan wheel is supported at both ends by ball bearings which are capable of carrying a load greatly in excess of the existing load, the balls being $\frac{5}{8}$ in. in diameter. The design of this blower is such that the overhang of the bucket wheel at one end and the fan wheel at the other end is a minimum and as nearly balanced as possible. By means of spacing rings and nuts, everything on the shaft is properly located and held rigidly. The ball bearings are entirely enclosed, the covers forming an oil-tight chamber. Without proper enclosure, the bearings, over which the air, laden with dust, passes, are sure to wear out in a very short time.

The bucket wheel is provided with a ring which projects into the casing and forms a close running fit but not a bearing. This ring is provided with grooves, in which steam, escaping from the turbine casing condenses and when it leaves the last groove, it is in the form of water.

THE GENERAL ELECTRIC CO. has recently issued Bulletin No. 902, which describes Sprague Electric Grab-Bucket Cranes, with special reference to the handling of coal. Their economy, scope, speed and simplicity of control are emphasized.

BOOK REVIEW

LIGHT: ITS USE AND MISUSE, a primer on light and illumination which was published last month by the Illuminating Engineering Society, 29 West 39th Street, New York, has already gone into a second edition. Written in a clear and comprehensive manner for popular reading, this little pamplet has met with immediate favor. It has occasioned considerable complimentary criticism from people who are generally supposed to have little or no interest in the subject of lighting. From the heads of engineering and physics departments of schools and colleges the society has received numerous letters of recommendation together with requests for quantities of the primer for distribution to students. Architects, engineers, oculists, merchants and others have also expressed their appreciation of the publication. Several lighting companies are planning to issue it to their customers. One large manufacturing company in London has cabled for permission to print and distribute a large edition in Europe. It is not unlikely that the primer will go into many editions.

THE "MECHANICAL WORLD" Electrical Pocket Book for 1913 has been received at this office. It is 4 by 6, a convenient size for carrying in the pocket and contains 240 pages aside from a diary in the back.

In this edition a number of pages have been added and some of the sections have been rewritten and expanded. In particular is this the case with sections dealing with generators and motors, and with electrical measuring instruments. A new section on magnetic circuits and magnetic materials has been introduced; also one on load, demand, diversity and power factors. Other new sections deal with electric motor applications, motor control by switches, fuel in central stations, depreciation, etc.

CATALOG NOTES

ALBERGER GAS ENGINE CO., of Buffalo, N. Y., has recently issued a catalog describing its tandem gas engines.

WM. C. ROBINSON & SON CO., of Baltimore, is distributing among its patrons a small calendar for 1913, similar to those issued for previous years.

THE SOOTHSAYER, a booklet from Albany Lubricating Co., 708-710 Washington St., New York, has reference to Albany grease.

"Don'ts for Buyers of Lubricants" is the title of a circular on the same subject.

ATLAS BALL CO., of Philadelphia, has issued a catalog describing its balls of imported chrome alloy steel, the highest grade of which is asserted to be round and true to size within 1/10,000 in. The processes of manufacture, from forging to polishing, are interestingly explained.

BISMARCK, for having welded the elements of a loose confederation into a strong empire, is classed among Makers of Unions and his career is summarized from an interesting point of view in a folder of the historical series issued by the Jefferson Union Co. Some comparisons are also made in reference to Jefferson unions in Folder No. 3, which may be obtained from the manufacturers at Lexington, Mass.

THE STERLING DESTRUCTOR, a publication issued by the Griscom-Russell Co., 90 West St., New York, describes many installations of the destructor, which is an English high temperature furnace for the disposal of municipal refuse and industrial waste.

J. P. LISK, of 15 Quincy St., Brooklyn, N. Y., has forwarded a blue circular of Universal saddles for supporting tanks, boilers and feed water heaters, 18 in. to 18 ft. in diameter.

THE CLING-SURFACE CO., 1028 Niagara Street, Buffalo, N. Y., has gotten out its 1913 calendar, dedicated to the N. A. S. E. and its members, and, as long as they last, will gladly mail one to any engineer asking for it.

THE BABCOCK & WILCOX CO., 85 Liberty St., New York, has just issued a catalog entitled "The Stirling Water-Tube Boiler."

LOOMIS-PETTIBONE gas generating system for water gas and producer gas manufacturers a substitute for oil for furnace work where high and low heats are essential. Several advantages of the system are enumerated, the apparatus and operation are explained and the cost is compared with that of fuel in oil fired furnaces, in Bulletin 106, from Power and Mining Machinery Co., of Milwaukee.

CONSIDERATIONS GOVERNING THE SELECTION of a modern steam engine are discussed in an illustrated bulletin, No. 1, from the Harrisburg Foundry and Machine Works, Harrisburg, Pa. Simple and compound single valve and Corliss valve engines are compared, and an illustrative problem shows the relative steam consumption.

THE GENERAL ELECTRIC COMPANY has designed and standardized switchboard panels which long experience and accurate knowledge of requirements have demonstrated will successfully meet the demands for which they are intended, and has just issued two bulletins; one illustrating and describing alternating current switchboard panels for three-phase, three-wire circuits, of 240, 480 and 600 volts, 25 to 60 cycles, and the other describing direct current switchboards, double polarity, 125, 250 and 600 volts. These bulletins are numbered 4996 and 4995, respectively.

"ECONOMY IRRIGATION BY PUMPING," is a book which will be found attractive and interesting by those who have any leaning toward out-of-door pursuits, as well as to those who are interested in their machine. It shows what is being accomplished by irrigation in the great western country, how it is being accomplished, and the machinery that is adopted for such work. It explains the different methods of irrigation, the obtaining and distribution of water, measurement of the water flow, and the arrangements of pumping parts, both electrical and gas engine driven. Tables also show the friction of water in pipes, the consumption of gasoline for pumping, electric current needed for pumping, the discharge from nozzles and other important hydraulic data. The book can be obtained from the American Well Works, Aurora, Ill.

HOMESTEAD VALVES and other specialties are described and illustrated in the 1912 catalog of the Homestead Valve Mfg. Co., of Homestead, Pa. Advantages of their construction are given and comparisons are made with other types of valves.

TACHELLA OIL-BURNING DEVICES, made by Tachella & Krieger, 916 Victoria Bldg., St. Louis, Mo., are adapted to isolated industrial heating apparatus such as that for dwellings, baking ovens, fire engines, metallurgical heating, street and railroad car heating. The device is shown in Bulletin N. 4, issued by the maufacturers.

HEWES & PHILLIPS IRON WORKS, Newark, N. J., has recently issued a catalog on improved double-ported Corliss steam engines. Various designs are illustrated by engravings. The range of sizes varies from 50 to 1000 hp. in noncondensing engines, and from 150 to 1500 hp. in compound condensing engines. All details of the engines are made upon the duplicate and interchangeable system.

INSTRUCTIONS FOR STOPPING LEAKS in screw-thread pipe joints will interest engineers. Those desiring a copy of this circular may obtain one by sending name and address to the Smooth-On Mfg. Co., 572-574 Communipaw Ave., Jersey City, N. J.

THE DEANE OF HOLYOKE, a triple-plunger artesian well pump, is described as meeting all requirements for pumping large deep wells and delivering 40 per cent more water than a double-acting or 2-plunger pump of the same size and speed. Illustrations show the pump and the method of driving the pistons. The manufacturers are the Deane Steam Pump Co., 115 Broadway, New York, and the bulletin is D225.

BALLWOOD WELDED FLANGES, for steam, air, gas and hydraulic piping, are made of wrought steel of the same grade of metal as the pipe. They are described as averting accidents and inconvenience resulting from leaks due to faulty steam joints. Circular 104, on this subject, has been received from the Ball and Wood Co., 17 Battery Place, New York.

ISOLATED AND SMALL PLANT switchboards for use with gasoline-electric sets, and for alternating and direct current, are described in the General Electric Co.'s Bulletin No. 4037. While designed primarily for use with the company's gas-electric generating sets, they are suitable for use in any generating units of the same rating, and are intended for small lighting plants.

BULLETIN NO. A4036 describes the General Electric Co.'s direct-current exciter panels for use in connection with alternating-current generator panels when, for any reason, speed control of exciters is desired. They are designed for controlling exciters of capacities ranging from 5 to 100 kw. This bulletin supersedes the company's previous bulletin, No. 4917, on this subject.

"PROGRESSION and the Lentz Engine," published by Erie City Iron Works, Erie, Pa., quotes from instructive articles on the value of dry steam and superheat. The Lentz engine is illustrated in detail.

The same company has issued pamphlets on the following subjects: horizontal water-tube boilers; horizontal tubular stationary boilers, built on a minimum factor of safety of 5; vertical water-tube boilers, also having a safety factor of 5, some of whose characteristics are metal casing outside the masonry setting, superheated steam, ease with which repairs are made and avoidance of frequent necessity for repairs; a report of results of quality of steam from Erie City vertical water-tube boiler, contained in Bulletin No. 2; the "Economic" boiler, represented as safe, economical and compact; Erie City shaking grates, with illustrations showing them complete and in detail.

THE SMOOTH-ON MFG. CO. has just issued a new edition of its Smooth-On iron cement book No. 7. Smooth-On iron cement No. 7 is a hydraulic, chemical iron cement, prepared and sold in powdered form and used for waterproofing, stopping leaks of concrete, hardening concrete and for bonding concrete to concrete and brick to brick or any porous substances. The new instruction book is illustrated, showing a few of the many ways in which this Smooth-On iron cement No. 7, has been used and the results obtained. It will prove valuable and interesting reading to anyone troubled with concrete leaks or the hardening of concrete. A copy of this book will be sent free of charge to anyone sending name and address to the Smooth-On Mfg. Co., Jersey City, N. J.

THE REMINGTON OIL ENGINE CO., 120 Broad St., New York City, has issued Bulletins 8-C-12, 11-D-12 and 9-E-12, which show interestingly several purposes for which Remington engines are intended. Marine types are used in freight, passenger, tug and fishing boats, etc. Among the uses for which the stationary types are designed are electric lighting, compressing air, refrigeration, milling and manufacturing.

STEAM SPECIALTIES, Catalog No. 3, from Schade Valve Mfg. Co., 2528-2538 North American St., Philadelphia, illustrates many types of valves, explaining the construction and application of each.

FROM DETROIT ENGINEERING Society, member of Association of Engineering Societies, we have received the 1912-1913 Year Book with list of members, and constitution and by-laws of the society.

"A FIRE DEPARTMENT in your building" is the title of a folder showing the J-M Success liquid fire extinguisher, manufactured by H. W. Johns-Manville Co.

TRADE NOTES

YORK MANUFACTURING CO., York, Pa., announces the following among plants recently installed:

Washington Terminal Co., Washington, D. C., one 40-ton ice-making absorption machine, and one 40-ton can ice-making plant; Prag Distilled Water Ice Co., Delhi, India, one 65-ton vertical single-acting refrigerating machine and cross compound engine; Silver City Power Co., Silver City, New Mexico, one 10-ton flooded ice-making plant; Schenley Hotel, Pittsburgh, Pa., one 20-ton standard vertical single-acting compression side and refrigerating plant; Cochrane Packing Co., Kansas City, Kansas, one 11-ton motor-driven compression side and brine refrigerating plant; Desel-Boettcher Co., Corpus Christi, Texas, one 11-ton refrigerating compression side and direct expansion refrigerating plant; Wayne County Canning Co., Marine, N. Y., one 11-ton refrigerating compression side; Kent Co., Ltd., Montreal, Canada, one 8-ton refrigerating compression side and direct expansion refrigerating plant for E. & A. Leduc, Montreal, Canada; Fleischmanns Restaurant, New York, N. Y., one 6-ton steam-driven refrigerating compression side and refrigerating plant; Independent Ice Co., Wilmington, N. C., 12,000 ft. of 1¼-in. brine piping with brine mains, 2000 ft. of 2-in. direct expansion piping and connections, also 50-ton shell and tube brine cooler with exchanger, dehydrator, etc., for additions to present absorption refrigerating plant; Peoples Ice Co., Carthage, Mo., one 18-ton ice-making plant and miscellaneous material; Schaffner Bros. Co., Erie, Pa., one 80-ton horizontal double-acting refrigerating compression side and pipe connections to present refrigerating plant; Doffinger's Dairy, Elverson, Pa., one 11-ton steam-driven refrigerating compression side and refrigerating plant; Grand Market Co., Denver, Colo., one 6-ton belt-driven compression side and refriger-

ating plant; A. W. McDonald, Newman, Cal., one 17-ton belt-driven compression side and refrigerating plant; Excelsior Creamery Co., Barallo, Miss., one 8-ton belt-driven compression side and refrigerating plant; Gilman Bros. Co., Ocean Park, Cal., one 4-ton belt-driven compression side and refrigerating plant; Rhodes Bros. Co., Tacoma, Wash., one 4-ton belt-driven compression side and refrigerating plant.

ON DECEMBER 14, 1912, the City of Youngstown, Ohio, awarded to the Kerr Turbine Co. contract for an Economy turbine, direct-connected to a Wilson-Snyder centrifugal pump, the duty being 80,000,000 foot pounds. This and a triple-expansion reciprocating pump with a duty of 163,000,000 foot pounds, are to be used in the pumping plant at Youngstown, the turbine pump to be installed in 90 days and ready to carry the load, while the older machinery is being replaced by the triple expansion Todd pump. This arrangement is one used by the City of Chicago, under the direction of Col. Henry A. Allen; the triple expansion engine operating with a low coal consumption for the regular load, and the turbine, which has low first cost and small fixed charges, being installed as supplementary to carry extra loads.

THE GOULDS MFG. CO., Seneca Falls, N. Y., announces that the Mine and Smelter Supply Co., Denver, Colo., have been appointed as agents for the Goulds line of triplex power pumps. Their territory will include the entire state of Colorado and adjacent counties in the states of Wyoming, New Mexico, South Dakota and Montana.

THE AUTOMATIC STEAM TRAP & Specialty Co., manufacturers of the Barton Automatic steam trap, has decided to combine its Cleveland, Toronto and Detroit offices and manufacturing interests under one roof. All communications after Jan. 1, 1913, should be addressed to The Automatic Steam Trap & Specialty Co., 316-20 Harper Avenue, Detroit, Mich.

THE DEARBORN CHEMICAL Co., has employed Mr. Warren P. Sayers of Cincinnati in its sales department, Mr. Sayers will assist Mr. Dan Delaney, manager of the Cincinnati office, in the surrounding territory.

THE RATEAU STEAM REGENERATOR CO., 140 Cedar St., N. Y., has been awarded a contract by the Carnegie Steel Co. for a complete Rateau patent steam regenerator equipment for their Homestead Steel Works, Munhall, Pa. The regenerators are to regulate the exhaust of a plate mill delivering steam intermittently at the rate of 260,000 lb. an hour, and will supply a steady flow of exhaust steam to a mixed pressure turbine of 3750 kw.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., reports the following list of recent sales:

Independent Brewing Co., Seattle, Wash., 95-ton refrigerating machine direct-connected to 18 by 42-in. Corliss engine; Davidson Bros. Co., Des Moines, Ia., mfrs. confectionary, 42-ton refrigerating plant and 14 by 30-in. Corliss engine; Richmond Cold Storage, Richmond, Va., 20-ton can ice tank and equipment; Plymouth Brewing Co., Plymouth, Wis., 10 by 30-in. Corliss engine; F. G. Vogt & Son, packers, Philadelphia, Pa., 65-ton refrigerating plant and 16 by 36-in. heavy duty Corliss engine; Swift & Co., packers, Chicago, 50-ton steam-driven refrigerating machine direct-connected to 15 by 30-in. heavy duty Corliss engine; Vaccaro Bros. Co., Commission Merchants, New Orleans, La., 10-ton can ice-making plant with two 5-ton can ice tanks direct-connected to 10 by 30-in. horizontal Corliss engine; Franklin Ice Cream Co., Kansas City, Mo., direct expansion piping; Gambrinus Stock Co., Cincinnati, O., 34 coils atmospheric ammonia condenser; The Railways Ice Co., Newton, Kas., 65-ton refrigerating machine and 16 by 36-in. Corliss engine; Peoples Artificial Ice Co., Shenandoah, Pa., can ice tank and equipment; Henke Artesian Ice & Refrigerating Co., Houston, Texas, 16 coils atmospheric ammonia condenser; Horlick's Malted Milk Co., Racine, Wis., direct expansion piping, etc.; Consumers' Ice Co., Sioux City, Ia., 60-ton can ice plant and 20 by 42-in. heavy duty Corliss engine; Pennsylvania Railroad Co., Philadelphia, Pa., 65-ton refrigerating plant direct-connected to 16 by 36-in. Corliss engine; American Ice Co., Washington, D. C., 75-ton plate ice plant.

THE U. S. STEEL CORPORATION has ordered 1069 Golden-Anderson cushioned triple acting and non-return valves for its power stations.

THE H. W. JOHNS-MANVILLE CO. announces the appointment of Mr. C. S. Berry as manager of its Atlanta, Ga., office, located at 31½ So. Broad St. To facilitate delivery in the south a stock of roofings, packings, pipe coverings and other J-M asbestos, magnesia and electrical products is carried at this above address. This office also employs a force of workmen experienced in the application of J-M products.

THE H. W. JOHNS-MANVILLE CO. has recently opened a new Southern warehouse at No. 31-½ South Broad St., Atlanta, Ga. The entire building, embracing 3 floors and a basement, with a total floor area of about 10,000 sq. ft., will be utilized exclusively as a warehouse for a stock of such J-M products as roofing, boiler and pipe coverings, cements, packings, fire extinguishers, electrical, railway and automobile supplies. A feature of particular advantage in this new site will be found in the location of the Atlanta office of the H. W. Johns-Manville Co., in the same building with the local warehouse, which will materially help to minimize the chance of delay in deliveries.

THE ALBERGER PUMP AND CONDENSER CO., of 140 Cedar Street, New York, announces that it now possesses the exclusive right to manufacture and sell the Hammond meter. This meter has been largely used in power stations for keeping an accurate record of boiler feed. It is also adaptable for measuring other fluids, and is ideal for use in modern industrial plants.

AN IMPORTANT CONTRACT for valves has recently been secured by the Swenson Valve Co., of Decorah, Ia. These are for the entire lubricating system of the big hydraulic plant at Keokuk, and the first shipment will be 165 valves, ranging from ¼ in. to 2 in.

IT HAS BEEN FOUND that the use of the Mexican Boiler Graphite prepared by The United States Graphite Company, Saginaw, Michigan, will not only prevent scaling and pitting in accumulator tanks of hydraulic elevator systems, but will lubricate the valves of the entire system, piston rods of pump, etc. One has only to throw 20 or 25 lb. into the surge tank, whence it passes into the acumulator tank through the pump and in fact, the entire system. Of course this initial dose should be followed from time to time with smaller ones.

Sparks From The Advertising Pages

The advertising of manufactured commodities benefits the producer, the middleman and the consumer. Most people know that. But not a few are to be found who, while admitting the tremendous selling force of advertising, will deny that any advantage accrues from it to the "ultimate consumer"—the man who "foots the bills."

The reasoning of such people usually finds expression thus: Advertising is so much expense added to the manufacturing and other costs of the article in question. Now, the consumer pays for all the material costs and service costs that go into any manufactured article, and, consequently, he pays for the advertising of it too.

This, of course, is true. But the statement overlooks a very important factor in the problem, and in so doing, is virtually a fallacy. It is assumed that the consumer, in paying the cost of advertising, derives no benefit therefrom; that an article, when it is not advertised, costs so much and when it is advertised, costs as much, together with the additional (prorated) expense of advertising it—expense for which the buyer receives no value.

But there are several important respects in which the consumer is benefited by the advertising of an article.

Without advertising, many articles which people value highly, would be unknown to them. And not only that. Advertising also enables the public to discriminate in the selection of articles —to weigh comparative merits and so to obtain that which is best adapted to individual use and taste. Is not this a service to which value must be assigned in considering the total cost of an article?

But, more important still is the consideration that it is the best brands of goods that are advertised, and that the mere fact that an article is advertised serves as a guarantee of quality to the consumer. There are doubtless exceptions to this rule, but they are few and unimportant. An advertiser's business sense tells him that to advertise articles without merit is a sure way to waste money. Now, is not this item of protection in buying advertised goods, of some pecuniary value to the consumer?

However, these advertising "values" do not compare in importance with this consideration: Advertising tends to cut down the price of manufactured articles. A manufacturer, let us say, turns out and sells annually, without advertising, one thousand of his product. By advertising it, he may increase sales to 2,000 or 3,000 with comparatively little additional outlay for labor and equipment. The cost of the product is reduced in spite of advertising expenditure, and, of course, also, the price to the consumer. We say "of course," because in competition with his rivals, the manufacturer finds it to his interest to make the price of his product as low as is consistent with business prudence.

The reader of Practical Engineer's advertising pages will readily admit the force of these considerations. There is unquestionable "educative" value in these announcements, especially to the reader who obtains and assimilates the literature offered freely by our advertisers. Nor, when the character of the advertisements is studied, will it be doubted that they amply sustain the argument that it is the "best goods" that are advertised—and that these are the cheapest too, when quality is weighed along with price.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—BY CAPABLE AND INDUSTRIOUS young engineer; 24, at present in charge of 2000 H. P. Corliss engine in large steel mill, have been in same place 3 years. Will start in as oiler or fireman in modern steam electric plant, but only when there is chance for advancement. I. C. S. graduate steam electric course. Chicago license. A.1. references. Address Box 271, Practical Engineer. Chicago, Ill. 1-15-1

POSITION WANTED—BY STEAM ELECTRICAL ENGINEER. Technical education. 5 years practical experience. Middle West or North preferred. Employed, but desire change for good reason. A-1 references. Address Box 270, Practical Engineer, Chicago, Ill. 1-15-1

POSITION WANTED—BY YOUNG MAN as oiler or engineer helper. Strictly sober and reliable man, willing worker. Address R. W. Peterson, 1041 S. Euclid Ave., Oak Park, Ill. 1-15-1

POSITION WANTED—AS CHIEF ENGINEER by man of 35, life experience in electric power and refrigerating plants (both systems), 9 years' in two large plants Institute education; will consider erecting. Total abstainer. Address Box 272, Practical Engineer, Chicago, Ill. 1-15-1

Wanted

WANTED—Man of wide acquaintance among engineers to solicit subscriptions for Practical Engineer in Pittsburgh, Pa. A good opportunity for the right man. tf.

WANTED—WILL CONSIDER buying patented specialty with established trade. State particulars fully. Address Box 269 Practical Engineer, Chicago, Ill. 1-15-1

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once. tf.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money. Write to Subscription Department. tf

For Sale

FOR SALE—10x22 Corliss engine, in perfect condition, entirely overhauled, wheel 9 ft. by 14 inches, r.h. $375 f.o.b. New York. Duzets & Son, 40 Church St., New York.

FOR SALE—A 32 H. P. HORNSBY-AKROYD Oil Engine with starting device, in very good condition; also a 15-ton Challoner refrigerating machine, oil separator, double pipe ammonia condenser and high and low pressure gauges. These are also in good condition. For particulars inquire of the Rahr Br'g Co., Oshkosh, Wis. 1-1-6

FOR SALE—FOUR DIRECT CONNECTED engine and generator sets 25 to 75 kilowatt capacity. Two 17x15-inch straight line engines, built for direct connection or belted service. One 14x12-inch, late type, automatic and one 16x36-inch Corliss engine, water tube and horizontal boilers full sizes. Twenty-two round, open steel tanks 10 feet 6 inches by 7 feet high. H. P. Brearley, 90 West St., New York, N. Y. 1-15-1

FOR SALE—PERKINS' TABLES—A BOOK of formulae and tables covering I. W. Pr. calculations of steam boilers including details of joints, head bracing, staybolts, etc., for all conditions of pitch and plate. A reference book for the inspector, the boilermaker, the designer of steam boilers, mechanical engineers, boiler constructors, and all mechanics brought in contact with steam boilers. The tables are accurate and the formulae simple and correct. Results are quickly obtained thus saving valuable time and labor for designing engineers, inspectors and boiler manufacturers. The work is the result of years of study by a graduate of the U. S. Naval Academy, Engineering Dept., at Annapolis, and a person having a high position in this line of work. Price, $5.00 a copy, book 5½ by 7 inches. See "Power" issue of August 20, 1912, and "Locomotive" of October, published by the Hartford Steam Boiler Insurance & Inspection Company, Address the Publisher, Lyman B. Perkins. 38 Huntington St., Hartford, Conn.

Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf

PATENT APPLICATIONS—Prepared and prosecuted for $25. Send for booklet. Harry Patton, 330 McGill Bldg., Washington, D. C. tf

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson & Son, Patent Solicitors, 710 G. St., Washington, D. C. 1-1-2

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request, 186 McGill Building, Washington, D. C. tf

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges, bound in leather. tf

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf